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ILLUMINATING ENGINEERING

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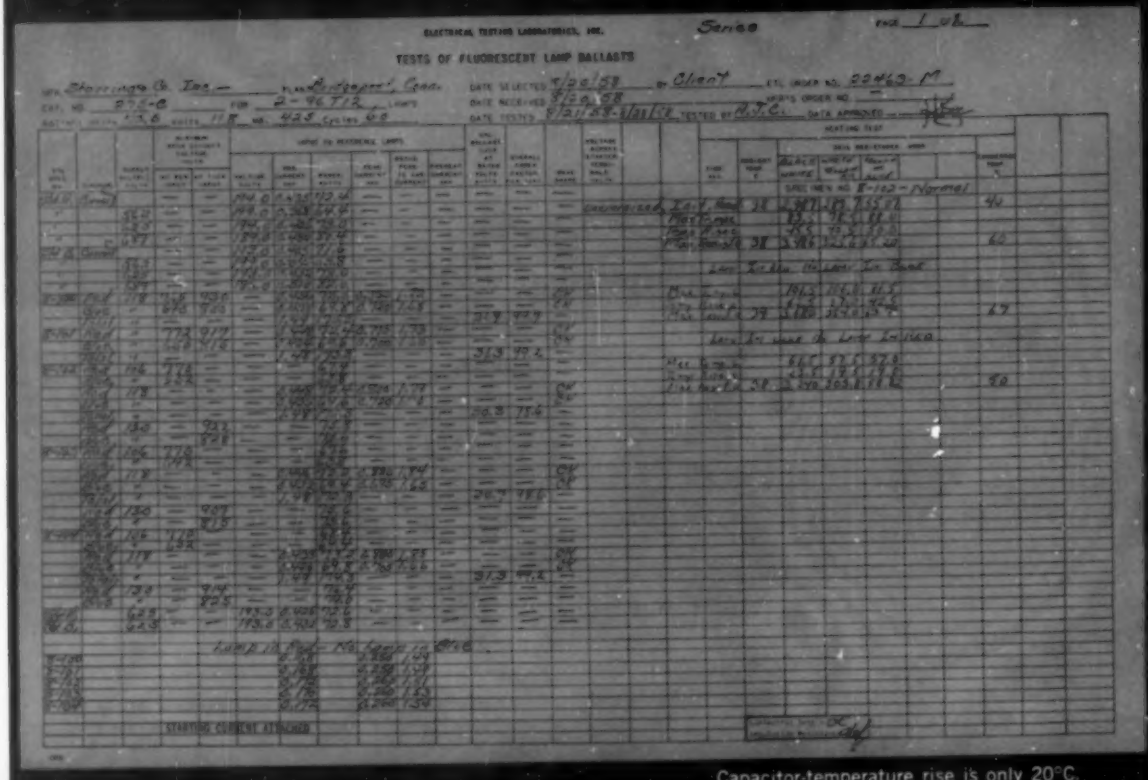

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THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

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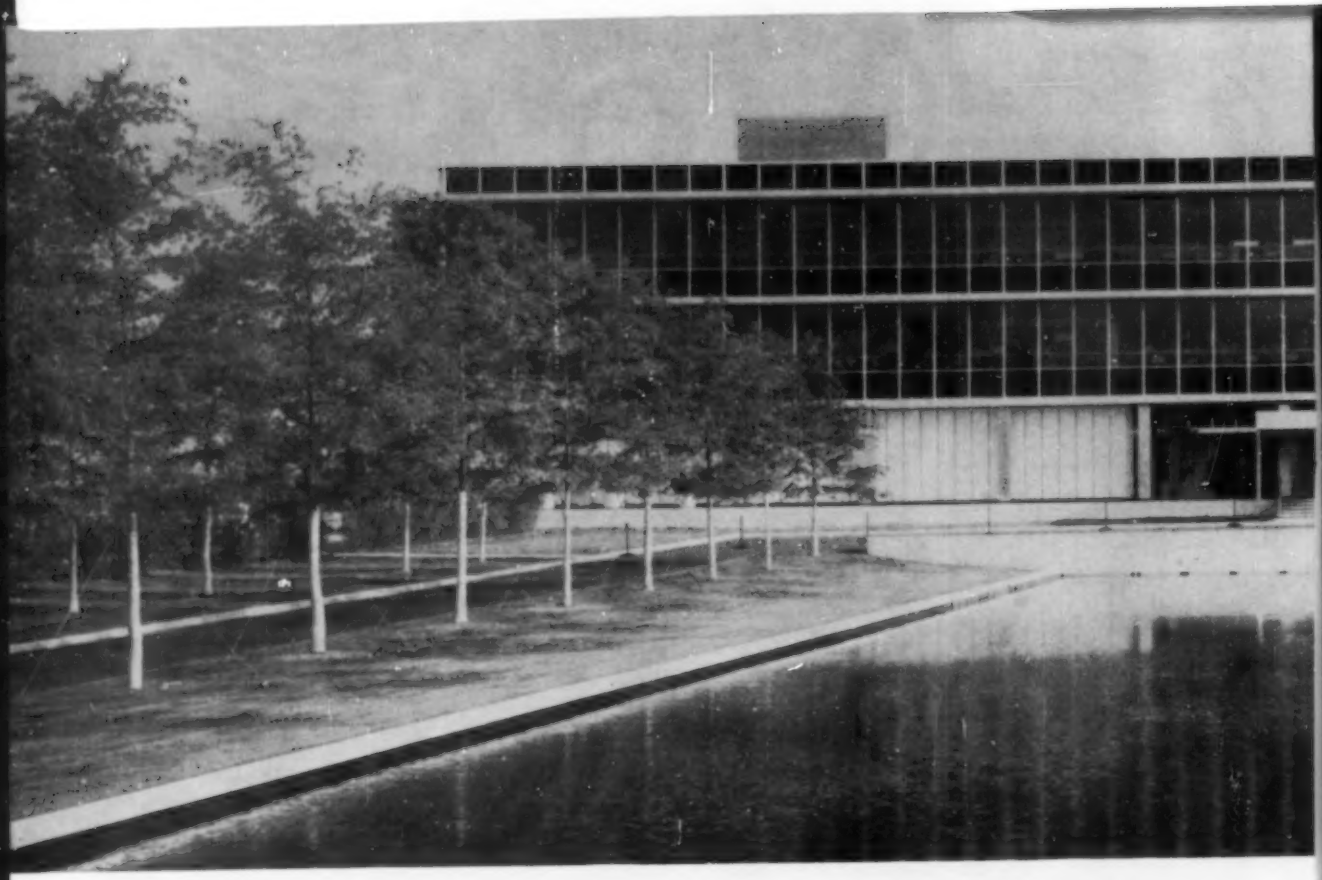

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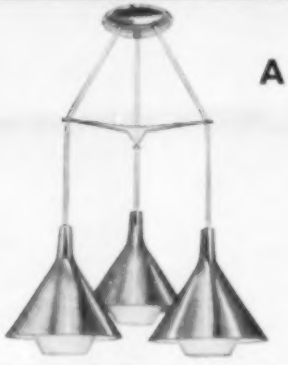

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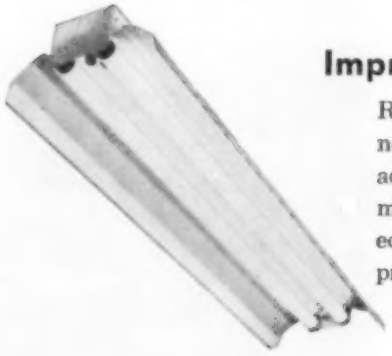

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Dallas Memorial Auditorium

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MANY different functions have been scheduled for the new Dallas Memorial Auditorium, such as conventions and exhibitions, stage entertainment, basketball and tennis tournaments, ice shows, circuses and boxing and wrestling matches. And the lighting was designed to adapt for these various purposes.

The memorial is composed of several structures: an arena building, a passageway to a theatre building and a servicemen's monument. A 1000-car asphalt-paved parking lot, lighted to a level of one footcandle by 1000-watt improved-color mercury lamps, is adjacent.

Leslie E. Hamilton, *North Texas Section, Southwestern Region, won first prize with this installation in his Regional contest for My Most Interesting Lighting Job. Mr. Hamilton is with George L. Dahl, Architects & Engineers, Dallas, Texas.*

Arena Building

High glass walls, with a canopy sheltering a pedestrian walk around the building, attract attention to the brightly lighted interior. Incandescent downlights are recessed in the canopy to illuminate the walkway and incandescent floods are mounted on top of the canopy to dramatize the upper portion of the building.

Immediately inside, the arena concourse has the appearance of the outer rim of a wheel with rows

Exterior — Arena Building.

of recessed fluorescent fixtures as spokes. The arena room, itself, is the hub of the wheel and around it are more than 1700 feet of fluorescent lighting in coves on two floors. This also serves as back lighting for the signs identifying entrances to the arena room, concessions, rest rooms and exits. Incandescent units add to the general lighting over the ramps.

The arena room is 300 feet in diameter and seats 10,000. Lighting levels of 15 to 30 footcandles are provided on the main floor from 400-watt improved-color mercury vapor lamps mounted in an acoustical saucer 70 feet above the floor. Also recessed in the saucer are incandescent units, used for flood-lighting a stage.

Over the balcony is a 40-foot wide band with fluorescent luminaires recessed in the ceiling. These furnish part of the 20 to 30 footcandles general lighting in this area.

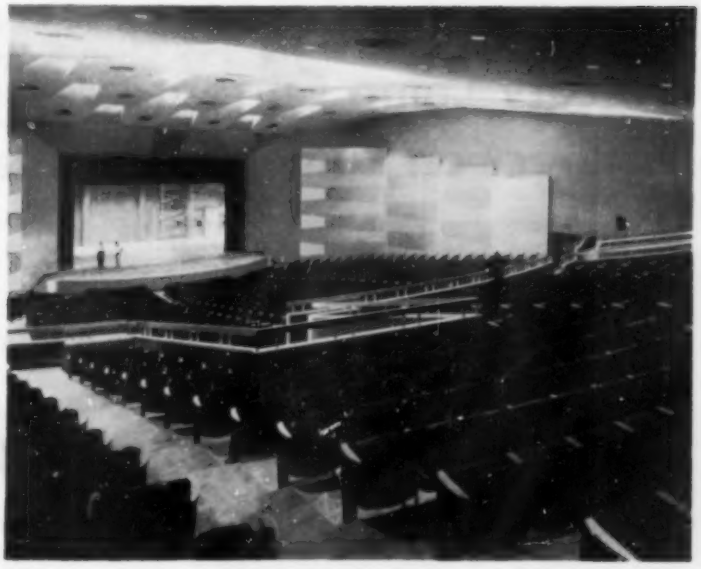
When the arena is used for boxing or wrestling, the center ring of 24 mercury units is lowered to 26 feet above the floor. This provides 350 footcandles without the help of general lighting. A ring of incandescent cove lights at the edge of the dome is used for esthetic effect.

Separate rectangular patterns of light are avail-

Interior — Arena Building.

← Under the saucer

Over the saucer →



Auditorium and stage — Theatre Building

able for tennis and basketball, with or without the general lighting. Levels of 60 footcandles are provided for ice shows and circuses, supplemented by spots and floods as needed. Light control equipment is remotely located, in the upper ring overlooking the arena floor.

Under the arena dome and above the acoustical saucer, incandescent units light the cat-walks used for maintenance of the mercury vapor fixtures and cove lights.

An exhibit area, located in the basement of the arena building, has general lighting from fluorescent fixtures mounted in concentric circles and wheel spoke patterns, to fit the ceiling structure. Recessed adjustable spotlights highlight displays in the center area.

Theatre Building

There is additional exhibit space in the theatre building, and lighting here is from suspended fluorescent fixtures. Stairs, leading up from this area to the theatre lobby are lighted by fluorescent coves, with two and three lamps per cove.

The theatre lobby, with its high curtained windows, faces the arena building. In a two-story section, continuous rows of recessed fluorescent units are lamped with de luxe warm white lamps. Under the balcony, square patterns of recessed fixtures each provide three lighting levels. In the corners of each square are incandescent units connected on emergency circuits.

The 1700-seat theatre is lighted by recessed downlights and fluorescent cove lights in the ceiling. The downlights are connected to the house dimmer board and can be remotely controlled from the orchestra pit, the projection room at the back of the theatre, and from the stage lighting control board. The downlights and coves can be operated independently or together and provide a variety of lighting levels. Light ports for stage lighting spot lights are built into the first and third rows of vertical ceiling panels, and acoustical wall panels are outlined by fluorescent coves which conceal front stage lighting spotlights.

Stage lighting equipment is remotely controlled using 44 dimmers and 200 circuits. An additional 2800 amperes of 120-volt supply is available for traveling shows with their own stage lighting.

Other lighting in the theatre building includes committee rooms with recessed fluorescent fixtures, stairways with recessed incandescent downlights and decorative lighting of planters.

Measurement of

Mercury Lamp Current Crest Factor and Its Effect on Lumen Maintenance

By E. C. MARTT
R. J. SMITH

An earlier I.E.S. paper by Noel and Martt[1] outlined the effects of high lamp current crest factor on the lumen maintenance of general lighting mercury lamps. The extensive discussion of that paper indicated that others were concerned about high crest factor, but not all were in agreement on the crest factor value of existing ballasts or on the magnitude of its effect on lumen maintenance. This paper presents accurate and practical ways to measure crest factor and more complete information on its effect on mercury lamps.

Measurement of Crest Factor

The wave shape of the current through a mercury lamp on a 60-cycle power supply is not exactly sinusoidal but has various degrees of distortion, depending upon the type of ballast used to limit the current. The accepted criterion for measuring the amount of distortion is the crest factor, which is the ratio of the peak value to the root-mean-square (RMS) value. The crest factor increases as the wave becomes more peaked. The crest factor measurement does not identify the exact wave shape, but for wave shapes commonly found in mercury lamps it is the most useful measurement that can be made. Since there are many ways of measuring crest factor, we felt that a comparison of the most promising methods should be made to determine accuracy, ease of measurement and equipment expense. These are discussed under separate headings below.

Method 1 — Magnetic Oscillograph With Graphical Analysis

In this method, a magnetic oscillograph is used to reproduce the current wave shape on light-sensitive paper. The oscillograph galvanometer is connected across a low resistance in series with the lamp in order to reproduce the current wave form. This wave trace is then measured accurately, and from these measurements, the root-mean-square value is calculated; the peak value is measured, and the crest factor is obtained by division. The accuracy of this method depends upon the purity and stability of the resistance used to obtain the galvanometer signal, the ability of the oscillograph to reproduce the wave shape accurately, and the accuracy of measuring the resulting wave shape.

The characteristics of the resistance in series with the lamp are very important. It must be non-inductively wound, and it must not change resistance during measurements. Most laboratory standard resistors are satisfactory for this purpose. For our measurements, a 0.1-ohm, 15-ampere standard resistor was used with 400-watt lamps which operate at about 3.2 amperes and 135 volts.

One of the errors in an oscillograph recording is caused by the galvanometer mirror moving in an arc while the wave shape is reproduced on flat paper. This error is small if the deflection from center is less than five degrees, but readings must be corrected if greater deflections are used. The oscillograph manufacturer will supply the amount of correction to be made. On our oscillograph, a five-degree deflection from center gave a trace height of about one inch, and the recording error was about .002 inches. Since this was about our measuring error, it could be neglected for this trace height.

Another source of error in a magnetic oscillograph recording is the frequency response of the galvanometer. Galvanometers are available which have a flat frequency response from 0-2000 cycles or better and draw about 25 milliamperes for one-inch deflection, and this is quite adequate for the wave forms with which we are concerned. We found that peak deflection as a function of input voltage (proportional to current) is exceptionally linear and stable for this type of galvanometer.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, August 17-22, 1958, Toronto, Ont.
Authors: Large Lamp Department, General Electric Co., Nela Park, Cleveland, Ohio.
This paper accepted by the Papers Committee of I.E.S. as a Transaction of the Illuminating Engineering Society.

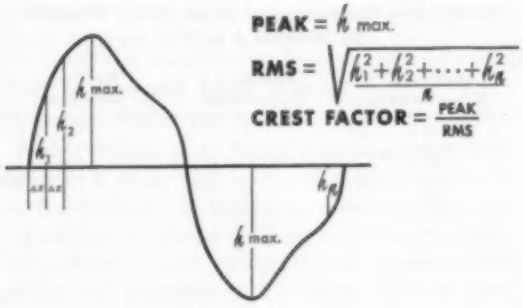


Figure 1. Method of measuring wave shape and calculating crest factor.

Measurement of Wave for Method 1

In order to determine, graphically, the crest factor of a wave trace, it is necessary to measure the wave height at equal intervals shown in Fig. 1 as h_1, h_2, etc. Once the heights at these equal intervals have been measured, the RMS value can be calculated according to the formula shown in Fig. 1. The crest factor is then determined from the ratio of h_{max} to the RMS calculated value.

In order to measure the heights h_1, h_2, etc. in Fig. 1, we found that a special measuring board was very convenient. This is shown in Fig. 2. The horizontal screw on the measuring board moves the magnifier (with crosshairs) one or more equal increments across the wave. The height at each interval is determined by moving the crosshairs with the vertical screw until the center of the line is reached. The height is then read on the dial micrometer.

In order to check the accuracy of this method, the crest factor of a 60-cycle pure sine wave supply was determined for waves with peak heights ranging from 0.4 inch to 1.5 inches from center. The trace of a complete cycle was about 2.5 inches long, and the value of each increment Δx in Fig. 1 was about $^1/_{60}$ of the cycle length. The crest factors of seven separate wave traces were determined, and the maximum difference from that of a pure sine wave was 0.8 per cent. We concluded that this method was sufficiently accurate for our purposes.

The accuracy of the calculated RMS value increases with the number of increments; however, the work involved also increases. In order to see how the accuracy changed as the number of increments changed, two complete half cycles were measured with different increments in a trace in which one cycle was about 2.5 inches long. The results of these measurements are shown in Fig. 3. For a sine wave, it was found that only 10 increments for the entire cycle were necessary to be within 1 per cent of the 60-increment value. However, for a more peaked wave with a crest factor of about 2.0, it would be necessary to have no fewer than 20 increments. Hence, the number of increments necessary depends on the wave shape being measured and the accuracy desired. For most lamp current measurements the number of increments needed will be between 10 and 20. With this relatively few number of increments, the amount of labor needed to determine crest factor is within practical limits.

The above graphical method has the advantages of independence of meters, and accuracy in the 1 per cent range, which compares favorably with good meters. Also, this method records a permanent trace of current wave shape. The disadvantages of this method are the cost of the magnetic oscillograph and the need for a reasonably accurate measuring board. The method also is somewhat time-consuming, since 30 to 45 minutes are required to measure the crest factor of each wave trace. However, because this method is very accurate, we believe it should be used as a standard.

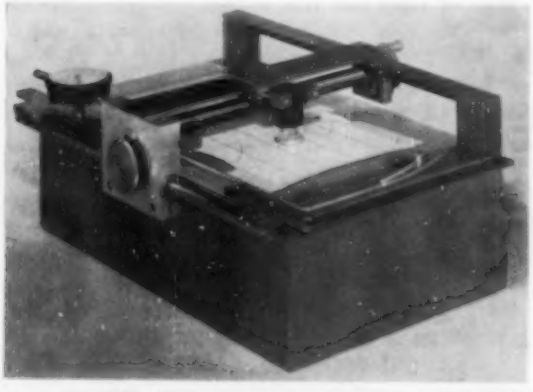


Figure 2. Board for measuring wave trace to determine crest factor.

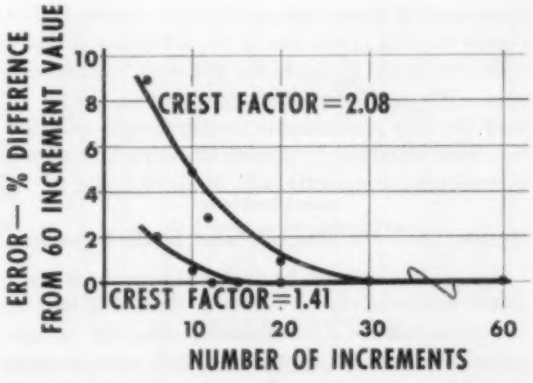


Figure 3. Error of calculated crest factor as a function of the number of increments used in measuring.

Method 2 — Magnetic Oscillograph With RMS Ammeter

With the galvanometer of the magnetic oscillograph connected across the resistance described in Method 1 above, the galvanometer can be calibrated on a pure sine wave so that peak deflection in amperes is determined. The wave shape in question can then be recorded and the peak height can be measured on the measuring board shown in Fig. 2. If, while the trace is being taken, an accurate ammeter is used to read the RMS current, the ratio of peak to RMS can readily be determined. A set of four separate readings were taken, comparing Method 1 with this method, and there comparisons are shown in Table I.

The maximum difference from the graphical method was found to be 2 per cent. Part of this error could be in Method 1, which was assumed correct for comparison purposes.

The advantage of this method over the first is that it is much faster, and the accuracy obtained should be quite acceptable for nearly all purposes. However, the equipment required is the same as in the first method, and so, for laboratories which do not have a magnetic oscillograph, this may still be too expensive.

Method 3 — Peak-Reading Voltmeter and RMS Ammeter

A peak-reading voltmeter can be used to obtain a signal proportional to the peak current from a resistance in series with a lamp, and an ammeter can be used to measure the RMS value. In order to determine the stability of the peak-reading meter, it was calibrated on an approximate sine wave four separate times after warming up for 30 minutes before each run. We found that in these four runs, the difference between these values and the values obtained by Method 1 varied as much as 7 per cent. Experience by others in fluorescent lamp work indicates less error by this method. The reason for this is not due to the difference in lamp types but more likely to the different instruments used. We concluded that this method should be used for only approximate measurements, and that the values obtained from such an instrument should be compared frequently with Methods 1 and 2.

Method 4 — Oscilloscope and RMS Ammeter

An oscilloscope can be used in the same manner as the peak-reading voltmeter in Method 3, that is, to determine the peak height (calibrated in amperes) of a current wave whose RMS value is measured by an ammeter. This is probably the most common method used, and its accuracy depends largely on the stability and linearity of the oscilloscope used. We found an error of about 3 per cent with a medium-priced oscilloscope. Most of this error is due to the instability of the instrument and to the inability to read the trace height accurately. We do not regard this method as being accurate enough for a standard, yet it seems to be acceptable for many requirements and has the further advantage that the wave shape can be seen immediately. Because of the wide variations in oscilloscope quality, we believe that values of crest factor obtained by this method should be checked against Methods 1 or 2 when readings are critical.

TABLE I — Comparison of Crest Factor Obtained by Methods 1 and 2.

Method 1 Crest Factor	Method 2 Crest Factor	Per Cent Difference
1.414	1.414	0.0
1.417	1.416	−0.1
1.414	1.427	+0.9
1.418	1.429	+0.8
1.421	1.439	+1.3
2.076	2.089	+0.6
1.989	2.028	+2.0
2.086	2.072	−0.7
1.949	1.960	+0.6

Repeatability of Lamp-Ballast Combinations

Assuming that an accurate measuring method is available for determining crest factor, the question is asked, "Will the lamp-ballast combination repeat wave shapes?" A number of repeat tests were made with various conditions on a stabilized-type ballast using Method 1 to measure crest factor. Fig. 4a shows crest factor as a function of line voltage for various lamp voltages, and Fig. 4b shows crest factor as a function of lamp voltage for various line voltages. From these figures, it is evident that once the variables of line and lamp voltage are taken into account, crest factor values can be repeated very accurately. Ballasts should be rated at center values of lamp and line voltage. If center values

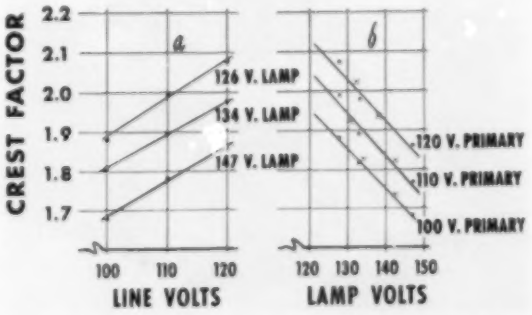


Figure 4. Crest factor as a function of lamp and line voltage for a particular 400-watt ballast.

are not used, corrections can be made from curves similar to those in Fig. 4.

Effect of Current Crest Factor On Lumen Maintenance

With a reliable crest factor measurement method available, a mean lumen *vs.* crest factor function could be defined. In designing a suitable test, the problem was to choose between the many parameters available. Both stabilized and non-stabilized ballasts are available with various current crest factors and wave shapes. These are used with lamps of varying lamp voltage, and in a variety of fixtures which burn lamps horizontally or vertically. Other possible variables include the hours-per-start and ambient conditions. The number of possible combinations of available ballast, fixture, lamp, and ambient conditions necessitated that some specific choices be made.

For reference and control purposes, one of the ballasts used was of the non-stabilized type used on standard life test racks. The main series were four stabilized ballasts of commercial design covering a crest factor range from about 1.4 to 2.0. Both vertical-burning industrial fixtures and horizontal-burning street lighting fixtures were used. 400-watt, quartz arc tube, clear mercury lamps were chosen so that one-third of the lamps were near the high limit of lamp voltage (about 147 volts), one-third at the center (about 135 volts), and one-third near the low limit (about 124 volts). The combination of this lamp voltage variation with the ballast variation spreads the resultant current crest factors throughout the range being examined. One high-, one normal-, and one low-voltage lamp was burned on each combination of five ballasts and two fixtures. All lamps were burned on a ten-hour-per-start cycle indoors, with controlled supply voltage. After an initial 100-hour seasoning, the lamps were distributed among the test legs according to lamp voltage.

The current crest factor for each lamp was measured by Method 1, previously described. At the time of measurement, each lamp was operating on the particular ballast and in the particular fixture in which it was burned for the maintenance test. Fig. 5 shows typical wave shapes for the five ballast types used in this test. It is possible that ballasts giving the same crest factor but with greatly different wave shapes might give results differing from those in this test. Because these wave shapes are typical of the ones obtained with commercial ballasts, the results of the test should be representative of the results obtained in service.

Lamps were removed from test for periodic photometry and each lamp returned to the same burning position. Photometry data were integrated over 6000 burning hours to obtain mean lumens on each lamp. These were expressed as a percentage of initial (100-hour) lumens for convenience in the analysis of the maintenance of light output.

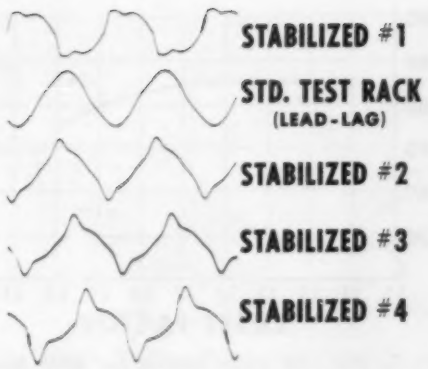


Figure 5. Typical wave shapes of ballasts tested.

The lumen maintenance data were checked for correlation with lamp voltage, ballast type, fixture type, and current crest factor. The correlation between lamp voltage and crest factor was similar to that already shown in Fig. 4. There was no correlation between lamp voltage and lumen maintenance other than that due to the change in crest factor. The data on the lead-lag ballast were equivalent to that on the stabilized ballasts at similar crest factors. Definite differences were noted between fixtures, and with varying current crest factors.

Maintenance results from the lamps burned horizontally in street lighting fixtures are shown in Fig. 6 as a function of current crest factor. This indicates 88 per cent mean lumens at a crest factor of about 1.5. Fig. 7 shows this same curve adjusted percentage-wise to a value of 85 per cent mean lumens at a crest factor of about 1.5 to bring it in

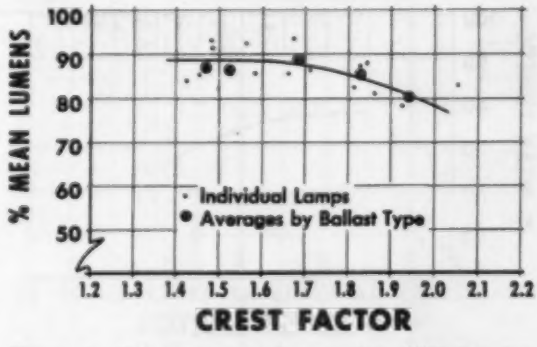


Figure 6. Per cent mean lumens for 6000 burning hours as a function of crest factor for horizontal operation of the H400-E1 lamp.

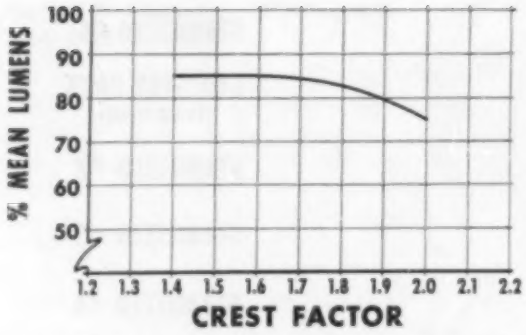


Figure 7. Per cent mean lumens for 6000 burning hours as a function of crest factor for horizontal operation adjusted for average lamps.

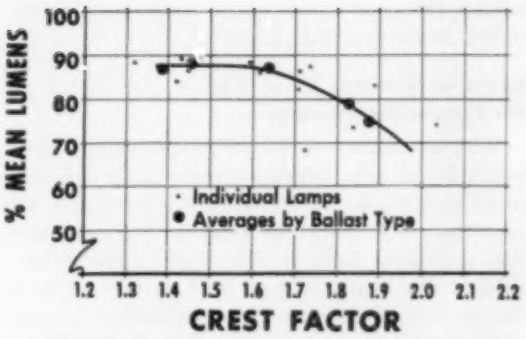


Figure 8. Per cent mean lumens for 6000 burning hours as a function of crest factor for vertical operation of the H400-E1 lamp.

line with average lamps. This latter curve is the one we would consider representative of average lamps in street lighting service at ten hours-per-start.

Maintenance results from lamps burned vertically in industrial fixtures are shown in Fig. 8. This indicates 87 per cent mean lumens at a crest factor of about 1.5. Average lamps show a per cent mean lumen value of approximately 78 per cent when burned in industrial fixtures at five hours-per-start. The higher results in this test are primarily due to the longer burning cycle. Fig. 9 shows the curve adjusted to the 78 per cent level. This adjustment was made in proportion to per cent mantenance; that is, all points are 78/87 of the corresponding points of Fig. 8. It would, of course, be possible to adjust the curve in proportion to per cent depreciation, that is, all points would be below 100 per cent by $(100-78)/(100-87)$ of the corresponding points in Fig. 8. Fig. 10 shows the results of both these methods and indicates an area of uncertainty due *only* to the transfer method. Further testing at five hours-per-start will distinguish between these curves. The curve representing average lamps in vertical-burning industrial service at five hours-per-start should fall in this area.

Evaluation on a Cost-of-Light Basis

The maintenance *vs.* crest factor functions shown in Figs. 7 and 9 can be used to compare the cost-of-light for ballasts differing only in crest factor. Cost-of-light for any installation is inversely proportional to the mean lumens. If one were to change to a lower crest factor ballast such that (from Figs. 7 or 9) 5 per cent greater mean lumens were obtained, then the total cost-of-light would be reduced by 5 per cent. Such a reduction in total cost-of-light could justify a much greater change in ballast cost, since the ballast cost is only a small part of the total lighting cost.

Comparisons between stabilized and non-stabilized ballasts involve more than just the effect of crest factor on lumen maintenance. The curves in Figs. 7 and 9 can still be used to determine the

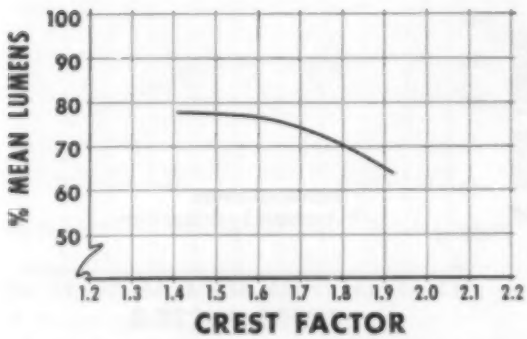


Figure 9. Per cent mean lumens for 6000 burning hours as a function of crest factor for vertical operation adjusted for average lamps.

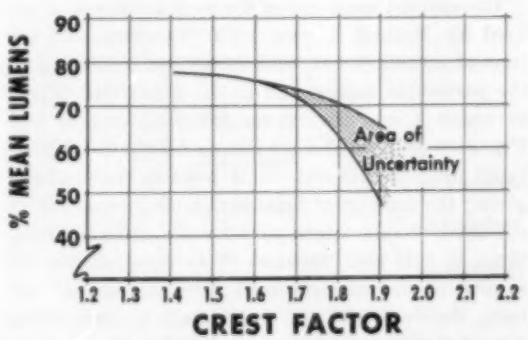


Figure 10. Per cent mean lumens for 6000 burning hours as a function of crest factor for vertical operation adjusted by per cent maintenance and depreciation.

difference in mean lumens, but additionally, allowances must be made for differences in ballast price, ease of installation, and the value of increased stability with varying line voltage.

Summary

This paper shows that for measuring crest factor, Method 1 has the accuracy of a good instrument, about 1 per cent, and should be used as a standard. Method 2 can be used where an accuracy of about 2 per cent is needed, and Methods 3 and 4 can be used for rough checking. Curves are given which show the method of adjusting readings to the center line, and lamp voltage that is required for a ballast rating.

Mean lumen *vs.* crest factor functions are shown for horizontal and vertical operation of average lamps over a crest factor range of 1.4 to 2.0. The effect of higher crest factors on cost-of-light is indicated.

Acknowledgment

The authors wish to thank Mr. J. R. Osborne for obtaining and analyzing crest factor data.

References

1. Noel, E. B., Martt, E. C.: "Effect of Operating Variables on Mercury Lamp Performance," ILLUMINATING ENGINEERING, Vol. LI, No. 7, pp. 513-531 (July 1956).

DISCUSSION

H. U. HJERMSTAD:* I wish to thank the authors for the opportunity of discussing their paper. The method they have outlined for obtaining crest factor is very complete and, as shown, provides excellent results. My objection to it is that it is very time consuming.

We have been using a method similar to that outlined in Method 4 of the paper. Referring to Fig. A, our procedure is as follows:

With the TPDT switch in *A* position, the voltage across the non-inductively wound resistor, *R*, (voltage drop less than 2 per cent of lamp operating voltage) in series with the lamp and ammeter is applied to the vertical deflecting plates of an oscilloscope. The vertical deflection is adjusted to an "arbitrarily predetermined magnitude." The RMS current through the lamp, ammeter, resistor circuit is recorded.

With the TPDT switch in *B* position, the resistor, *R*, and ammeter are connected to a low voltage transformer and variac supplied by a constant voltage transformer with harmonic filter. This is the RMS reference source. The supply voltage is adjusted so that the vertical deflection is the same as when the TPDT switch was in the *A* position. The RMS current is recorded. This current is multiplied by 1.414 and divided by the RMS current in the *A* position to determine lamp current crest factor. This technique provides continuous calibration of the oscilloscope.

Another refinement employed discards the normal lined

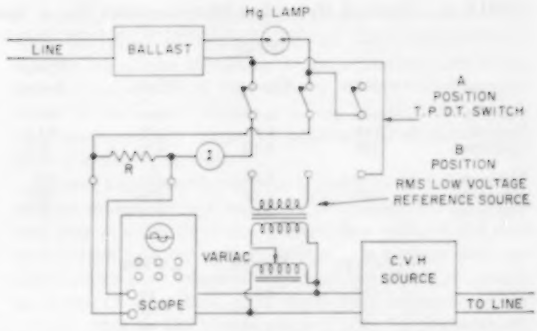


Figure A. Crest factor measurement.

transparent scope face. Instead, two pieces of transparent tape are applied horizontally directly to the face of the cathode ray tube, equi-distant above and below the vertical reference point. The "inboard" edges of the transparent tape form the previously mentioned "arbitrarily predetermined magnitude" for vertical deflection. This procedure reduces parallax materially.

Adjustment of vertical deflection magnitude is simplified if the horizontal deflection amplitude is reduced to zero. Then, a single vertical line is being manipulated and essentially the top and bottom points of the line are made to be coincident with lines on the face of the cathode ray tubes. This is much easier to view accurately than a "spread" waveform. Of course, the waveform can be spread at any time for observation and analysis.

The oscilloscope power is supplied by a constant voltage transformer with harmonic filter. This combination of techniques combine to a total significant improvement because, as the authors state, "Most of this error [they find 3 per cent error with Method 4] is due to the instability of the instrument and the inability to read trace height accurately."

We have found the above system to be accurate and reproducible and a convenient tool for making tests as design changes are being made.

Many questions concerning the effect of high and low voltage lamps, stabilized and non-stabilized ballast, having the same current crest factor for both vertical and horizon-

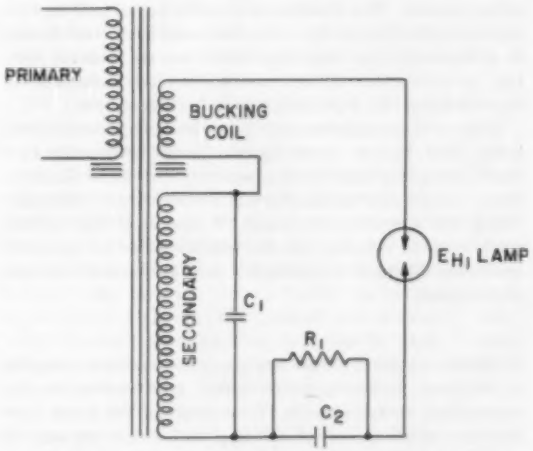


Figure B. Schematic diagram for constant wattage mercury vapor lamp ballast.

*Sola Electric Co., Chicago, Ill.

TABLE I — Typical Operating Characteristics for a Nominal Lamp Operating Vertically Base-Up and Horizontally.

	INPUT				OUTPUT				
	Voltage	Current	Watts	Power Factor	Current	Watts	Voltage	Current Crest Factor	Watts Loss
Lamp in Vertical Operation	100	4.71	458	97	3.25	408	133	1.42	50
	115	4.25	463	94.6	3.27	412	133	1.48	51
	130	4.10	470	88.2	3.30	415	133	1.59	55
Lamp in Horizontal Operation	100	4.65	452	97	3.16	400	134	1.35	52
	115	4.12	458	96.8	3.25	404	134	1.57	54
	130	4.00	459	88.2	3.25	408	134	1.71	51
	Voltage	Current	Watts				Striking Voltage		
Open Circuit Condition	100	2.20	35				310		
	115	2.34	40				330		
	130	2.50	40				305		

*Striking voltage measured with 30,000 ohm load on transformer to simulate the effect of lamp starting probe.

tal operation and their effect on lumen maintenance have been answered by this paper. However, in the last paragraph before the summary, the authors state that "Comparisons between stabilized and non-stabilized ballasts involve more than just the effect of crest factor on lumen maintenance." This would imply that a stabilized ballast will have a crest factor more detrimental to lumen maintenance than a non-stabilized ballast. This is not necessarily so.

Fig. 7 for horizontal burning lamps shows per cent mean lumens to be virtually flat out to the crest factor of 1.65. Constant wattage ballasts are commercially available today with a typical crest factor of 1.6 (see Table I) for a horizontal burning lamp.

Fig. 9 for vertical burning lamps shows per cent mean lumens to be essentially flat out to a crest factor of 1.55. Constant wattage ballasts having a crest factor of 1.5 for vertical operation is shown in Table I of this discussion.

A schematic diagram of a constant wattage ballast having these characteristics is shown in Fig. B. C_1 is used to resonate the high reactance transformer at three times line frequency or 180 cycles under no load conditions. This provides a means of increasing the secondary voltage to insure adequate starting for cold weather operation. Once the lamp has ignited, C_2 is placed in series with the lamp, transformer secondary, and bucking coil, and after the lamp has come up to full operating condition, the circuit operates at near resonance to provide practically unity primary power factor. The bucking coil reduces, materially, the peak currents through the lamp that cause high crest factor. It is apparent from this data that there are constant wattage ballasts which do not sacrifice lumen maintenance by the standards that have been set up by the authors.

With constant improvement in materials, it is conceivable, today, that ballasts could operate lamps by circuits that would provide substantially a square wave. With improvements in semi-conductors, there is a possibility of even providing d-c operation for lamps. I wonder if the authors would care to comment on the possible effect of a square wave and effects of d-c operation on high pressure mercury vapor lamps.

J. E. HAYMAKER:* There are many inter-related variables in the lamp, ballast and fixture that affect lumen maintenance, light output and life. The authors of this paper have done an excellent job of defining and measuring one of these variables. They are to be congratulated on their original contribution in the measurement of current crest factor.

As a ballast designer, I am very interested in data such as presented in the section of the paper on lumen maintenance. In order to put current crest factor in its proper perspective as far as lumen maintenance is concerned, I would like to know how other variables affect lumen maintenance. Some of the other factors which might affect lumen maintenance are: lamp position, hours-per-start, warm-up time, high or low lamp wattage, high or low RMS lamp current, fixtures, ambient temperature, starting current, lamp design and current wave shape.

Most of these other factors were acknowledged by the authors in the paper. A look at data taken from Figs. 7, 9 and 10 indicates the differences due to position, hours-per-start, and crest factor in this series of tests. At 1.5 crest factor, there is a 7 per cent increase in mean lumens in the horizontal position compared to the vertical position. There is a 9 per cent increase in mean lumens with 10 hours-per-start than expected with 5 hours per start. There is a 5 per cent decrease in mean lumens when the crest factor changes from 1.5 to 1.9 in the horizontal position. There is a 13 per cent decrease in mean lumens when the crest factor changes from 1.5 to 1.9 in the vertical position.

It would be interesting to have a composite picture of the major influences on lumen maintenance and the degree to which each factor influences lumen maintenance.

I would like to ask two questions on the material in the paper: (1) Were test ballasts adjusted to deliver 400 watts to the lamps or did wattage vary with position and lamp voltage? (2) What method was used to determine points on curve of Figs. 6 and 8?

M. E. ROBERTSON:* This paper does an excellent job of defining crest factor and its measurement as well as presenting a complete story of the effect of crest factor on lumen maintenance. The authors have worked hard and their labors have culminated in a paper worthy of great praise. I am grateful for the opportunity to discuss this paper.

The first part of the paper dealt with the measurement of crest factor. Here, the authors did an exceptionally thorough job and established two points which could well become industry standards. These are:

(1) A standardized method of measuring crest factor.

(2) A standard definition for establishing a crest factor

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*Jefferson Electric Co., Bellwood, Ill.

rating, "measure at nominal line voltage on a nominal lamp."

Referring to Figs. 4a and 4b, the authors used a line voltage range of from 100 to 120 volts. On commercially available ballasts, this range is 100 to 130 volts. This should be kept in mind, although the effect in their final results should be negligible.

The authors have told me that the non-regulated type ballast used was of a lag type having an open circuit voltage of 220 volts. A ballast of this type will deliver less wattage to both high and low arc voltage lamps than to nominal arc voltage lamps. Ballasts having an open circuit voltage of 300 volts will deliver more wattage to the lamp as the arc voltage increases. Since the lag ballast used would be operating the high and low arc voltage lamps at lower wattages, there should be less arc tube blackening and better lumen maintenance by the test procedure used. Had a 300-volt open circuit lag ballast been used, this point on the curve would have been slightly lower.

The paper does an excellent job of comparing the effect of crest factor on lumen maintenance for constant wattage or regulated ballasts. It can be used to evaluate regulated ballasts having different crest factors. It should never be used to compare a non-regulated to a regulated ballast. The authors checked only for lamp condition under standardized test conditions. They did not make measurements comparable to light on the street. A constant wattage ballast having a poor crest factor could very well maintain more light on the street over the life of the lamp. The reason is as follows: The arc tube voltage of a mercury lamp increases over its life. With 300-volt open circuit ballasts, more wattage is delivered to the lamp as the arc voltage goes up. This means an increase in light with an increase in arc voltage. A lag ballast produces two-thirds of one per cent increase in light output for each one volt increase in arc voltage. A constant wattage ballast produces one per cent increase in light for each one volt increase in arc voltage. At this rate, the regulated ballast gains one per cent in light output over the lag ballasts for each three volts increase in arc voltage over the life of the lamp. If the arc voltage increases three volts over a period of 6000 hours, then a regulated ballast having a crest factor of 1.75 would produce the same lumen maintenance as a lag type ballast having a crest factor of 1.4 (refer to Fig. 7).

The point of my remarks is to emphasize that this is an excellent discussion of constant wattage ballasts. This paper, however, cannot be used to compare conventional lag type ballasts with constant wattage ballasts.

H. A. Breeding:* Since mercury lamps, as used in street lighting, are usually operated in the horizontal position I think the information presented by Messrs. Martt and Smith will be received by the street lighting industry as welcome information. This is especially true since their results indicate that lumen maintenance of horizontally operated lamps is considerably less affected by crest factor than is the lumen maintenance of lamps operated in the vertical position. This information should further promote the use of stabilized ballasts in the future, especially where line voltage variation problems predominate or are likely to predominate on the system under study.

I am one of those who believe that the industry should sell "lighting" or perhaps "visibility" as opposed to merely "operation of lamps and lighting equipment." And, therefore, I agree with the authors, that many other factors than "just the effect of crest factors on lumen maintenance" must be considered in making a comparison between stabilized and non-stabilized type ballasts. The information presented in this paper brings us a step closer to being able to evaluate properly the use of a given type of ballast on a given distribution system.

Another important factor which would be of assistance in such an evaluation and on which little lamp life performance data is available is the effect of line voltages different from ballast primary voltage ratings. Or perhaps what we should really know is something about the effects of operating lamps at other than rated watts with information, for example, such as has been made available for incandescent filament type lamps.

Going back to the paper, in studying the data in detail, it is noticed that there is a rather wide spread to the data especially that shown in Fig. 8. Would the fact that "limit lamps" predominate in the test account for this somewhat wide scattering? It would seem that the data for the average lamp might have even more significance than the data for performance of lamps at the limit of manufacturing tolerance in voltage, since there will usually be many more lamps near the average voltage rating than at the extremes on any given circuit.

In the beginning of the paper, the authors have discussed and presented various methods of measuring current crest factor. A variation of their Method 4 which we find useful in our laboratory consists in reading the crest value of a sine wave on a cathode ray oscilloscope of good quality at the same RMS value of current as the ballast delivers to the lamp. The crest value of this sine wave is then compared with the crest value of the current wave delivered by the ballast under test and the ratio of the crests $\times$ 1.41 is taken as the current crest factor. To produce a permanent record, and reduce the chance of errors in reading, we have found it convenient to photograph both waves. With care we have found that we can repeat our measurements to within approximately one per cent using the above procedure if the same lamp is used in the same position on successive tests. In other words, the lamp and lamp position are important which implies the need for use of a standard lamp in making comparisons between ballast performance.

Merle E. Keck:* In an investigation to determine the reason for a variation in lumen maintenance between lamps operated on different control circuitry, I believe that at least the following points are suspect:

(1) Lamp wattage during operation;
(2) Open circuit voltage, crest and shape;
(3) Operating current wave shape;
(4) Crest current and time relationship during starting.

The authors have chosen four commercially available ballasts and one design which they use on their life test racks. The paper gives no indication that all the above factors were considered and that adequate investigation was made to insure that the only variable during the test was operating current wave shape. Let's look at each of these in turn:

(1) *Wattage* — The authors state that the range in crest factors was obtained by a choice in lamp voltage variation and ballast variation. I assume that line voltage was constant but I am not certain. It is certain that if constant line voltage is applied to a stabilized type ballast and if

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*Outdoor Lighting Department, Westinghouse Electric Corp., Cleveland, Ohio.

lamps with different arc voltages are connected to it, that the lamp wattage will vary quite considerably. This variation can be expected to be as much as from 375 watts for a 126-volt lamp to 438 watts for a 147-volt lamp. I feel certain that this under and over wattage operation will affect lumen maintenance.

(2) *Open Circuit Voltage, Crest and Shape* — One ballast used was a two-lamp type and may have been an indoor type with approximately 220 volts open circuit. The stabilized type ballast may well have had 300 or more volts crest on open circuit and widely varying open circuit voltage wave shapes. Considerable variation in both the crest value and shape occurs in the different stabilized ballast circuits now on the market. These variations in starting occurring each 10 hours could well be an important factor in the lumen maintenance.

(3) *Operating Current Wave Shape* — This is the factor considered in this paper.

(4) *Crest Current and Time Relationship during Starting* — Variations in lamp current RMS values, crest factor and time of warm-up between commercial ballast designs during starting and the warm-up period varies considerably. The probable sources of variation may be the current wave shape during warm-up and the duration of this warm-up time. There is no direct correlation between starting current wave shape and operating current wave shape.

The authors are requested to comment on the test procedure and to determine the effect of these variables on their results.

From an analysis of the data presented in Figs. 6, 7, 8 and 9, several pertinent conclusions and questions can be set forth.

(a) Lumen maintenance varies more as a result of burning hours per start at a crest factor of 1.4 than it does from a variation of 1.4 to 1.9 in crest factor with the lamps burned horizontally.

(b) From these data, lumen maintenance is not affected as much by crest factor when the lamps are burned horizontally as they are when burned vertically. Can the authors offer any explanation for this? Lamps operated vertically warm up more slowly than those operated horizontally which offers the possibility that the real difference lies in the current variations during the starting and warm-up period.

(c) Fig. 10 indicates an uncertainty as to the method of adjustment from 10 hours-per-start to 5 hours-per-start. If further tests at 5 hours-per-start indicate that the lower curve is followed, it would then follow that high crest factors have a much more severe effect at fewer hours-per-start. This appears to conflict with the authors' original premise that operating current crest factor is the cause of reduced lumen maintenance rather than some condition during starting which occurs from the same circuitry that, in this instance, produces a high operating current crest factor.

I must conclude that these data, while most interesting, still do not answer the basic question, "What factors in ballast circuitry are the most important as regards their effect on lamp lumen depreciation?" I feel it is incorrect to conclude from this paper that the way to judge the quality of a stabilized ballast circuit is to measure operation current crest factor and disregard the other factors.

We built, over two years ago, a number of specially constructed ballasts using the same basic circuitry to produce an operating current crest factor of 1.7, 2.0 and 2.2. Lamp life and lumen maintenance tests on these ballasts by our Lamp Division indicate no significant change in life or lumen maintenance due to these crest factors. These data would have been presented at the Conference except for the fact that a major change in cathode design recently made them obsolete. These tests are now being resumed with the new cathode construction and from these tests, I must conclude that more data and better control of the variables during starting are required before any conclusion can be drawn.

M. C. UNGLERT:* The work on methods of measuring crest factor accurately is indeed interesting and would prove valuable if it is found necessary to establish a crest factor limit for mercury lamp ballasts at some future date.

With regard to the crest factor vs. per cent mean lumens data, the number of lamps tested, especially in the high crest factor range is very limited, and the points so scattered as to leave some doubt as to just where a curve should be drawn.

Referring to Fig. 6, we might present some additional limited data which may help add to the picture at 2.0 crest factor, the lamps burning in the horizontal position with crest factor measured by Method 4 — Oscilloscope and RMS Ammeter. These results show 92 per cent and 84 per cent mean lumens for two lamps tested to 6000 hours and an anticipated 90 per cent based on three lamps tested to 4200 hours, still operating at 90 per cent of initial output. At present, we cannot explain the relatively good performance of these lamps except to assume that exceptionally good lamps were selected by the luck of the draw. (It might be noted that Fig. 6 shows a lamp at 2.05 crest factor, which is equivalent to a lamp at 1.42.)

It is quite evident that the sum total of data available is very limited at this time, and it is hoped that more will be obtained in the future in order to determine whether ballast crest factor has any appreciable effect upon mercury lamp operation.

J. M. HARRIS:** Crest factor plays an important part in determining the operation of a mercury vapor lamp. Excessive crest factors have been shown to produce deleterious effects upon the lamp. Of great importance is the method of measurement. Many times in the discussion of crest factor, its absolute value has often been a questionable factor, the reason being the method of measurement. The four methods outlined by the authors point out carefully and accurately the advantages and disadvantages of each method. It has been our experience, however, that the first method, the magnetic oscillograph with graphical analysis, is the most reliable and repeatable. Since only one piece of equipment is involved whose only function is to record the wave shape accurately, the probability of error is minimized. While the other methods may be desirable for some special or economic reason, the magnetic oscillograph with graphical analysis method is in our opinion the best for a standard and is not difficult to use for all occasions where crest factor measurements are required.

For some time there has been evidence that high crest factors were undesirable. Limits of various magnitudes have been set on various parameters of arc discharge devices. Fluorescent lamps have a very definite limit set in ASA on operating current crest factor and some limitation on open circuit voltage crest factor. Have your studies in-

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**Sylvania Electric Products, Inc., Salem, Mass.

dicated any adverse effects on lamp life or maintenance on ballasts which have high open circuit crest factors? We have definite mercury vapor experience that indicates the need for such limits. The data in this paper clearly show the effect operating current crest factor has on lumen maintenance. It has been our experience that under both controlled and field conditions, the higher operating current crest factor ballasts cause excessive lumen depreciation and may affect life. In your testing have you found any evidence which links life and crest factor?

Of special importance is the reference to cost of light. In the normal life of a ballast, considering 400 watts plus losses, a ballast with crest factor 1.7 or less could save enough power to completely pay for the cost of the ballast or at least justify any additional cost for the better ballast.

I wish to congratulate the authors on their fine and systematic paper which clarifies and evaluates the various methods of crest factor measurement. Their presentation of crest factor *vs.* lumen maintenance leaves no doubt as to the authority of their findings.

E. C. Martt and R. J. Smith:* Our aim in the measurement portion of the paper was to determine crest factor with the same percentage accuracy as lamps could be photometered, ± 1 per cent or better, and to compare the methods studied. This aim was accomplished. The methods presented can serve as a basis for comparing future results or in setting limits.

In our oscilloscope method we used most of the precautions outlined by Mr. Hjermstad. The oscilloscope trace was reduced to a single vertical line as he described. We also calibrated at each measurement, and care was taken to reduce parallax. The reference sine wave used was taken from a filtered supply having a crest factor of $1.412 \pm .010$ as measured by our Method 1. Despite these precautions, we obtained an error that varied up to 3 per cent and attributed the cause to a combination of instrument instability and error due to line width. If an accuracy of 1 per cent is desired, and if a trace height of one inch is used, a reading within 10 thousandths of an inch would be needed. Line width for the average oscilloscope is nearly 60 thousandths ($\frac{1}{16}$) of an inch, and so visual readings of the required accuracy are difficult. We found that the trace width made by the magnetic oscillograph was less than 15 thousandths ($\frac{1}{64}$) of an inch, and when measured on the board described, we could easily repeat height measurements within ± 2 thousandths of an inch. Mr. Breeding's pictures of the oscillograph trace could be used to advantage on the measuring device described in our paper, thus improving accuracy of measurements.

The inference in Mr. Hjermstad's measurement discussion is that an oscilloscope, properly used, is quite adequate for most work. We agree with this. His discussion covers the points to be watched — sine wave reference, continuous calibration, parallax. His measurements could be improved with better measurement of wave height. We agree with Mr. Harris, however, that our Method 1 using graphical analysis of a magnetic oscillograph trace has greater inherent accuracy than the other methods. When crest factor measurement is critical, as in presentation of data in a paper such as this, or in determining values close to limits, or in evaluating other measurement methods, then Method 1 should be used. Present-day galvanometers are stable, and they have a frequency response flat to the 30th or 50th harmonic of 60-cycle power. Line width can be very fine, and the final trace can be analyzed for crest factor by anyone with good measuring equipment without the need to know the constants of the circuit used.

Of course, everyone would like more performance data. The comments made have been sprinkled with requests for information on square-wave operation, d-c operation, operation at other than rated watts, operation at other than rated line voltage, effects of high crest factor open-circuit voltage, warm-up time, and a well-stated desire for a composite picture. It is disappointing that so little additional data were made available. Practically any lamp or ballast engineer can think of more questions in five minutes than can be answered with five years of testing. We can only hope that this paper which covers: (1) current crest factor, (2) horizontal and vertical operation, and (3) lamp voltage variables has cut a path through the center of the problem. Although we can't satisfy all the desires for more information, we do have answers to specific questions brought up in discussion.

In answer to a question, ballasts were not adjusted to 400 watts, but were chosen to deliver close to 400 watts to a center voltage lamp. One need not be uncertain about the constant line voltage, because the paper states " . . . controlled supply voltage."

One statement from our paper has been quoted a little out of context. Under the "Cost of Light" discussion in the paper, the statement was made, "Comparisons between stabilized and nonstabilized ballasts involve more than just the effect of crest factor on lumen maintenance." The reference is to the "Cost of Light" comparisons. In discussion here, it was said that this implied that a stabilized ballast will have a crest factor more detrimental to lumen maintenance than a nonstabilized ballast. No such implication is made. Quoting from the fourth page, "the data on the lead-lag ballasts were equivalent to that on the stabilized ballasts at similar crest factors." In Fig. 6, and also in Fig. 8, the second point of the "averages by ballast" is the nonstabilized ballast. For its crest factor, it falls in line with the series of four stabilized ballasts. The evidence, therefore, is that for the same crest factor both a stabilized and a non-stabilized ballast have the same effect on lumen maintenance.

The question was raised as to where the points were obtained for Figs. 6 and 8. On Fig. 6, individual points are shown by the small dots. The large dots represent the average of three lamps burned on similar ballasts. These three lamps were one each of high, center, and low lamp voltage. Some wonderment was expressed about the accuracy of drawing the line through the individual points. Actually, they were drawn through the averages shown. The question was also raised as to the difference in lumen maintenance between lamps of the various voltages. This was one of the many correlations of the data examined which were not included in the results shown in the paper. As explained, a ballast will deliver different current crest factors to lamps of differing voltage. The maintenance of these lamps does differ, but only in accord with crest factor differences.

We agree with Mr. Robertson's comments that a rising lamp voltage throughout life causes a stabilized ballast to deliver an increasing wattage to the lamp. This, of course, does not change the relationship shown in Fig. 6. For example, if the lumen maintenance with a rising wattage characteristic is higher than that shown here from lag circuit measurements, it is higher throughout the various crest factors of stabilized ballasts. If it is higher for a 1.9 crest

*Authors.

factor stabilized ballast, it is also higher for a 1.5 crest factor stabilized ballast. However, the effect should be taken into account in making the comparisons between stabilized and non-stabilized ballasts with which this paper does not principally concern itself.

Mr. Breeding comments that data for lamps of average voltage would be more significant than data for lamps covering the voltage tolerance range. This is part of the experimenter's choice in setting up such a test, and since crest factor decreases rapidly with increase in lamp voltage (Fig. 4b), we felt that lamps over the voltage range should be included. No correlation of lamp performance with changes in lamp voltage was found, probably because lamp wattage varies inversely with lamp voltage.

Theoretically, square-wave operation is desirable, but practical approximations may have effects which cancel out or override the theoretical benfits of square-wave operation. We should point out that the stabilized ballast No. 1 has a somewhat square wave. The results on this ballast are the first points on Figs. 6 and 8 and show no beneficial results. Possibly, a more perfect square wave with a significantly lower crest factor might give better maintenance results.

Although lamps are designed and rated for a-c operation, lamps have been satisfactorily operated on d-c with proper auxiliaries and precautions. For example, the electrode which acts as an anode should be in the cooler position so as to avoid overheating. Thus, in base-up operations, the connections to the lamp should be oriented so that the electrode farthest from the base is the one operating as the anode. The opposite would be true for base-down operation.

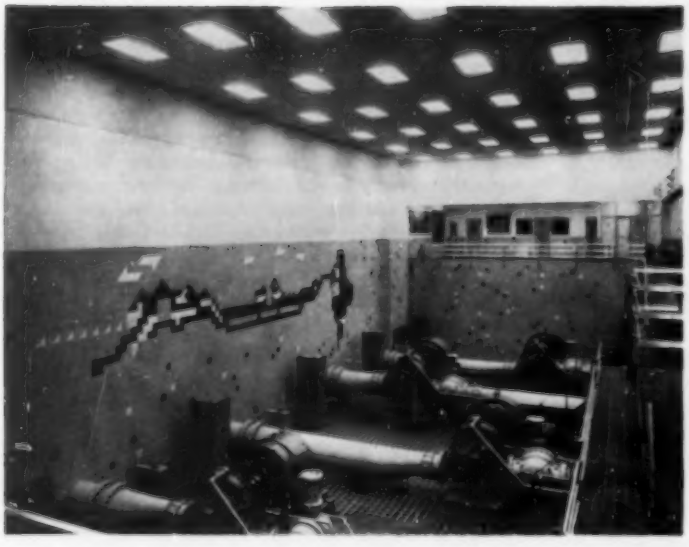
We cannot explain why lamps burned horizontally are more affected by high crest factor than those burned vertically. We disagree with Mr. Keck that warm-up time is a major factor, since we have found that lamps warm up as fast in a completely enclosed horizontal street lighting fixture as in an open-bottom vertical industrial fixture.

We agree with Mr. Keck that the lower curve of Fig. 10 would make a starting function more suspect than an operating function. It is included in the paper as a limiting possibility rather than because it is a belief favored by the authors.

With regard to Mr. Unglert's tests on five lamps which he deemed inconclusive, we can add the results of a test made prior to the one described in this paper. This test included a stabilized ballast of about 2.0 current crest factor and controls at about 1.5 current crest factor. Lamps of various manufacturers were burned on these two ballast designs. The results showed that all lamps were affected by crest factor to the same degree. We believe that Mr. Keck's statement that their data indicated no significant change in life or lumen maintenance due to crest factors is not borne out by Mr. Unglert's quoted results. This may be a case of not having significant data rather than having data showing no significant differences. If additional data are available, it is surprising to have it not presented. We did not feel that our announcement of superior-performance lamps was sufficient reason to withhold useful information on the present lamp which is used so widely.

No effect on lamp life has been noticed. Unless this effect was very great, we would not expect to detect it in this test. Actual mercury lamp life is a great deal longer than the 6000 hours economic life on which our tests were based.

We agree with Mr. Harris' comments that "Cost of Light" studies indicated that for typical service conditions a lower crest factor can more than pay for the ballast.



Pit area at the Coldbrook Water Pumping Station, in Grand Rapids, Mich., is 91 feet 6 inches by 35 feet 10 inches. Illumination at one foot from the floor is 20 footcandles, from 48 two-lamp 40-watt rapid-start 2- by 4-foot troffers. Fixtures are mounted on 6- by 12-foot centers at a height of 25 feet 6 inches. Fourteen of the units are equipped with 25-watt incandescent emergency lamps on separate circuit.

Lighting designed by William Winglar, architect and engineer with J & G Daverman Co., and L. A. Niemeyer, representative for Benjamin Electric Manufacturing Co., both of Grand Rapids.

INSTALLATION AT NORTHFIELD RACE TRACK, BEDFORD, OHIO.

Floodlighting a Harness Race Track

LIGHTING OBJECTIVE: To provide, for nighttime operation, shadowless, glare-free illumination so that spectators can distinguish the horses and drivers at any point on the track and so that the drivers can easily see to run the race.

GENERAL INFORMATION: There are facilities for approximately 7500 spectators at this half-mile track. The mean distance from the spectators to the track varies from approximately 120 feet on the home stretch to approximately 640 feet on the back stretch. The infield is beautifully landscaped and includes a lagoon.

INSTALLATION: Illumination is provided by 106 Class GP, Type 2 (Westinghouse VRC-20NP) floodlights, 56 Class GP, Type 3 (Westinghouse VRC-18NP) floodlights, and 140 Class O, Type 6 (Westinghouse VE-18) floodlights as shown in Fig. 2, each containing a 1500-watt incandescent lamp operated at 10 per cent over rated voltage. The Type 2 and 3 floodlights are mounted at approximately 60 feet above the ground on one steel pole located at the end of the curve coming into the home stretch and 4 towers located on the roof of the grandstand and club house. The Type 6 floodlights are mounted on small pipe poles at a mounting height of approximately 20 feet

(over)

A.I.A. File No. 31-f

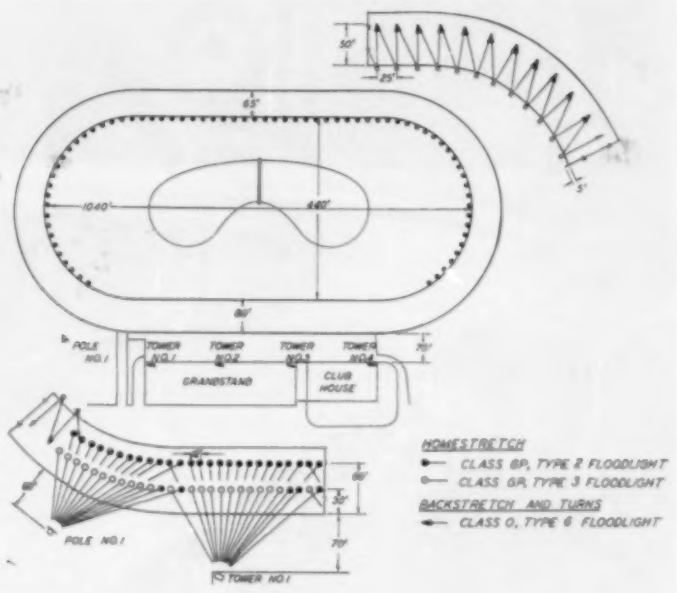


Figure 2. Plan view showing location of luminaires.

above the ground. To reduce glare in the eyes of the horses and drivers due to direction of the floodlighting, the units are aimed to cover an area of which approximately ⅓ is against the direction of travel and ⅔ is in the direction of travel. This reduces to a minimum the number of luminaires aimed toward the horse and driver while still maintaining high utilization. The average maintained illumination level is approximately 20 footcandles over the entire track, thus enhancing the appearance of the track and permitting the same ease of seeing regardless of the position of the horse and driver. To increase the ease of locating the horses, a white "reflector" fence is used.

Lighting designed by J. R. Bale of the Westinghouse Electric Corp. Contractor: Ray Electric Co., Cuyahoga Falls, Ohio.

Lighting data submitted by J. R. Bale of the Westinghouse Electric Corp., Cleveland, Ohio, as an illustration of good lighting practice and to aid in the design of similar installations.

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Vanderbilt Mansion near Asheville, N. C.

National Entry Class I

Staging an Opera on a mansion porch

When the Brevard Gala Festival Orchestra decided to present a production of *Carmen* on the front portico of the main house on the Vanderbilt estate near Asheville, N. C., they created, for the lighting engineer, a two-fold assignment. The installation for this one-night extravaganza was to be a combination of stage and environmental lighting. Illumination of the portico-stage and adjacent grounds had to provide an atmosphere in keeping with the mood of the production and, at the same time, display to advantage, the vastness and grandeur of this unusual setting.

The Vanderbilt mansion, 780 feet long and containing 367 rooms, is one of the finest examples of Renaissance architecture in the country. Its exterior, the principal area to be lighted, is built of hand-tooled limestone, carved by more than 450 French and Italian artisans renowned for their knowledge of Renaissance art and architecture. Intricate lacework carvings decorate the windows and balconies of the house, and many spired gables adorn its top. Curators agree that this mansion (circa 1890) is the most magnificent of its kind now in existence.

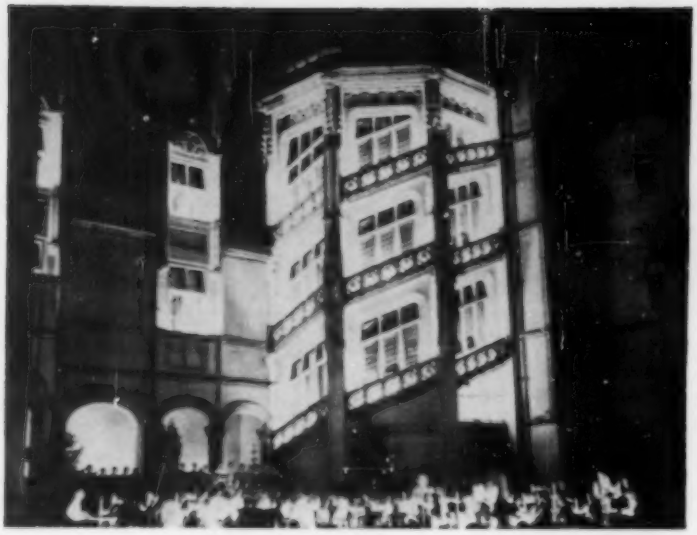
Robert E. Faucett, *Palmetto Section, Southeastern Region, who tied for Regional honors with this installation, is with the Outdoor Lighting Department, General Electric Co., Hendersonville, N. C.*

Since the lighting installation was for a "one-night stand" and financed by a non-profit organization, it was imperative that costs be kept at a minimum. Two other problems facing Mr. Faucett were the necessity for concealed, or at least inconspicuous lighting, and the availability of only two weeks and two men for planning, installing and checking the lighting system.

The initial plan involved placing conventional filament floodlights on the roof, behind the gables, and on the ground, behind potted plants in front of the stage. After a trial installation, however, this plan was discarded. The roof lights caused long objectionable shadows from the gables and resulted in areas of non-uniform brightness, obviating the location of the lighting equipment. The units on the ground in front of the stage were too bright for the performers and cast shadows which moved with the movement of action on stage.

A combination of fluorescent and filament lamps — fluorescent for the stage area and filament for the surroundings — seemed the logical solution. Floodlights with high-output fluorescent lamps were mounted one and two feet behind the grillwork in front of the windows and behind the columns supporting the portico roof. The wide beams available from fluorescent lamps permitted mounting close to the vertical surfaces to be illuminated.

An impressive depth was added to the opera scene by silhouetting the 150-voice chorus against the back-lighted columned portico. The floodlight-



Close-up of mansion showing chorus silhouetted against the back-lighted portico-stage and the effect of lighting nine cathedral windows enclosing a magnificent spiral staircase.

ing of nine cathedral-type windows to the right of the stage created an especially breath-taking effect.

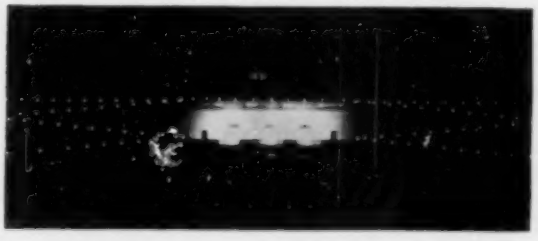
To increase the dimensions of the setting and use other parts of the estate to contribute to the atmosphere of the production, three areas surrounding the stage were also lighted. To the left of the mansion, a small pagoda-like structure known as the Summer House (the gateway to the estate gardens) was illuminated with one wide-beam filament floodlight. The garage area, or Stables as they are called, harking back to their original use in the 1890's, are located to the right of the house, seemingly attached to it. Two wide-beam filament floods, mounted in a window above an arched "drive-through" provided the illumination for this adjacent area.

As the audience left the "theatre" after the performance, they walked across the Mall and viewed a stone-walled terrace forming criss-crossed stair ramps, with three small fountains built into it. The stair ramps were outlined with specially designed candlelight units — a real candle placed in a sand-filled crockery flower pot and covered by a glass chimney similar to that used on kerosene lamps. These hurricane lamps were placed all along the edge of the stair ramps, and when seen reflected in the front Mall fountain gave an almost fairyland sparkle to the entire setting. Three PAR spots accented the fountains.

Near the end of the Mall, behind the terrace, at the top of a hill leading to other parts of the estate, is another pagoda-like building known as the Belvedere. With no power source available in this area, the Belvedere was lighted by application of the clever technique of using three small wide-beam floodlights with low wattage 6-volt lamps energized from a pair of automobile batteries connected in parallel.

This combination of the most modern fluorescent and filament equipment with the elementary light of the candle produced results that were dramatic, practical and economical. In fact, so well-received was this temporary installation that there is a strong possibility of installing a permanent lighting system for future productions in this truly exceptional theatre.

Stone-walled terrace and stair ramps, with Belvedere in background, as seen by day and by night.



Vertical Distribution of Light From Gas-Filled Candlepower Standards

By L. E. BARBROW
S. W. WILSON

Introduction

In recent years, gas-filled tungsten-filament lamps have been used in increasing numbers as standards of luminous intensity. These lamps are operated base down and have coiled monoplane filaments and clear bulbs. When used as standards, they are marked with fiducial lines so that they can be accurately aligned about a vertical axis.

Middleton and Mayo[1] have reported on the variation of candlepower of such lamps about the vertical axis. Reported herein are the variations of candlepower of several sizes of such lamps about a horizontal axis through the filament center perpendicular to the photometric axis. Table I lists the types of lamps studied and the number of lamps of each type.

Method

The lamps were operated at a distance of approximately 2 meters (80 inches) from a barrier-layer photocell, the current output of which was measured in a "zero-resistance" circuit.[2] The photocell was diaphragmed to 1.2 centimeters diameter, so that the receiver diameter subtended an angle of approximately 0.36 degree at the lamp. Each lamp was first oriented about a vertical axis so that the vertical lines etched on the bulb were in a plane through the center of the photocell diaphragm. By visual inspection, the plane of the filament was set to be vertical by tilting the lamp about the horizontal axis perpendicular to the photometric axis. This vertical angle is designated as 0 degrees. The candlepower of each lamp was measured at this angle and at one-degree intervals through ±5 degrees.

In accord with a practice in common use, a diaphragm 2½ centimeters high and 9½ centimeters wide was placed 4½ centimeters from the center of the socket, toward the receiver. Ample baffles were used so that stray light was excluded.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, August 17-22, 1958, Toronto, Ont. Authors: National Bureau of Standards, Washington, D. C. This paper accepted by the Papers Committee of I.E.S. as a Transaction of the Illuminating Engineering Society.

Results

The data obtained on the individual lamps are given in Figs. 1-4. It will be noted that the variation of candlepower through the range of tilt of ±5 degrees from vertical may be almost 10 per cent for the 500-watt lamps and somewhat less for the 50- and 100-watt lamps (excluding lamp 4398 which gave atypical results). These results point up (1) the need for specifying a procedure for orienting coiled-filament, clear bulb lamps about a horizontal axis as well as about a vertical axis if their use as candlepower standards is to be continued, or (2) the need for a change in the type of lamps used as gas-filled standards of luminous intensity, if no special precautions are to be taken for orientation of the lamp and for controlling the vertical angle subtended by the photocell.

Since the lamp and diaphragm were tilted as a unit, the obtaining of data through a wider range of angles was precluded. To obtain such data, measurements of the lamps in Group 4 were made without the diaphragm. These measurements were made at 2-degree intervals. The data obtained are shown in Fig. 5. In this figure, 0 degrees is the vertical angle of maximum candlepower instead of the angle at which the filament plane is approximately vertical as in Figs. 1-4. Plotted on this figure also is a cosine curve with an amplitude of 5 per cent of maximum candlepower and a period 18 degrees. This curve can be represented by the equation $100\,(I_o - I)/I_o = 5\,(1 - \cos 20\Phi)$ where I_o is the maximum luminous intensity and I is the luminous intensity at vertical angle Φ.

It will be noted that this cosine curve represents fairly well the average variation of candlepower of the lamps with angle of tilt. An apparent explana-

TABLE I — Types of Lamps Studied.

Group Number	Watts	Number of Lamps	Filament Form	Bulb
1	50	5	C-13	T-10
2	100	6	C-13	T-10
3	500	6	C-13	T-20
4	500	5	C-13B	T-20

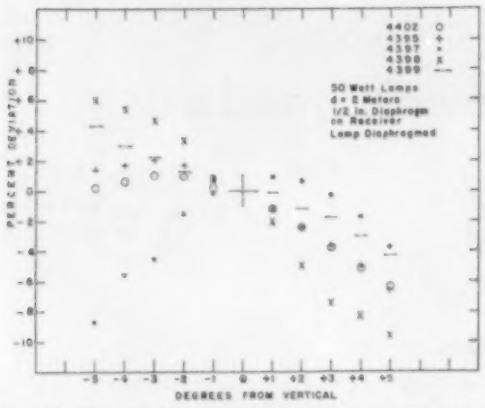


Figure 1. Per cent deviation of candlepower *vs.* angle of tilt of 50-watt, C-13 filament lamps, Group No. 1.

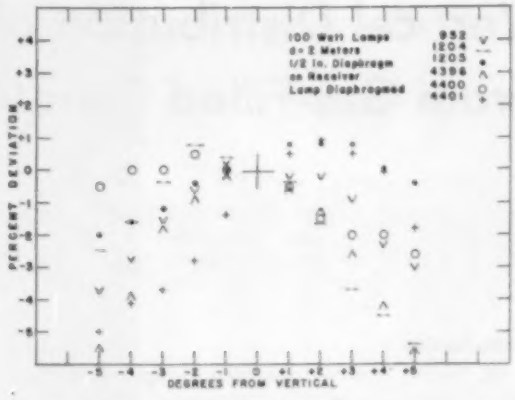


Figure 2. Per cent deviation of candlepower *vs.* angle of tilt of 100-watt, C-13 filament lamps, Group No. 2.

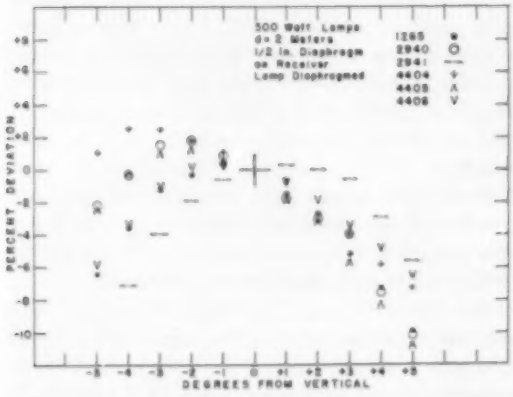


Figure 3. Per cent deviation of candlepower *vs.* angle of tilt of 500-watt, C-13 filament lamps, Group No. 3.

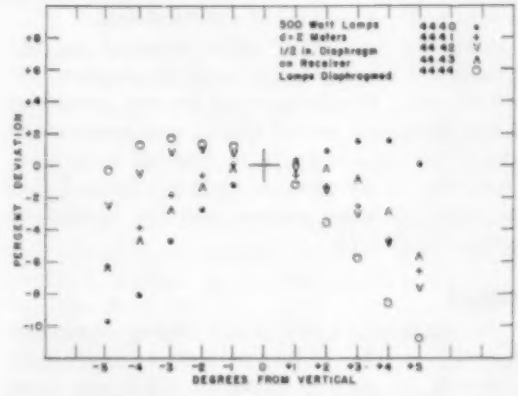


Figure 4. Per cent deviation of candlepower *vs.* angle of tilt of 500-watt, C-13B filament lamps, Group No. 4.

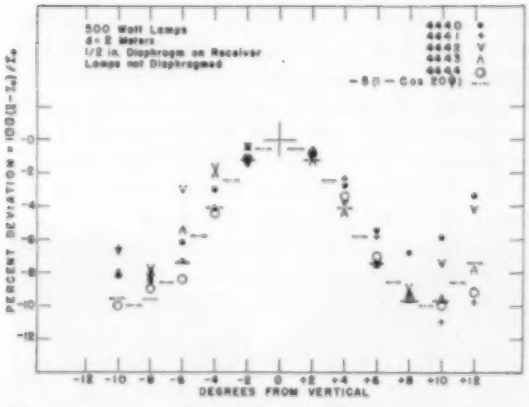


Figure 5. Per cent deviation of candlepower *vs.* angle of tilt of 500-watt C-13B filament lamps, Group No. 4. Also, a cosine curve with an amplitude of five per cent of maximum candlepower and a period of 18 degrees.

tion of this cyclic variation of candlepower with angle of tilt is that maximum candlepower is obtained when the orientation of the filament is such that the filament section at the rear of the coil is maximally viewed between the front turns of the coil, whereas minimum candlepower is obtained when this rear section is maximally eclipsed by one of the front turns. A measurement of the pitch of coil of several of the lamps verified this explanation.

Discussion

The procedure which has been followed at the National Bureau of Standards in calibrating gas-filled candlepower standards has included orienting each lamp so that the plane of the filament was vertical and perpendicular to the photometric axis. In view of the data herein reported, it is apparent

that such a means of orientation is not adequate since frequently the filament plane is not accurately definable. In addition, and quite unfortunately, the need for properly orienting coiled-filament lamps about a horizontal axis has not been stressed and it can be assumed that various laboratories use various methods of orienting about a horizontal axis, some laboratories merely screwing the lamps into existing sockets which affords means for orientation about a vertical axis but not about a horizontal axis.

To remedy this situation, two actions have been taken at the National Bureau of Standards. First, regarding the use of clear-bulb, gas-filled lamps as candlepower standards, the practice of specifying that each such standard must be oriented so that its axis is perpendicular to the photometric axis has been adopted. In addition, these standards are selected so that when they are oriented as specified above, the variation of candlepower of each standard with change of tilt about a horizontal axis will not exceed one per cent per degree of tilt. Users of the standards should have no difficulty in orienting lamps so that they are well within one degree from vertical.

In those cases in which greater reproducibility of results is required, such as in interlaboratory intercomparisons, in addition to vertical fiducial lines on each standard as in the past, horizontal fiducial lines are placed on each standard. These lines are 1¼ inches above the filament center and instructions are given to orient the lamp so that these lines are in a plane which is 1¼ inches above the photometric axis. The lines are etched on each lamp in a position such that when the lamp is properly oriented, the candlepower is a maximum. Accordingly, small deviations from proper orientation have a minimum effect. This procedure, however, as will be explained presently, is not deemed to give an adequate solution to the problem.

Second, steps have been taken that will probably lead to the use of a different type of lamp as gas-filled standards of candlepower. Several series of measurements of 300- and 500-watt lamps with inside frosted T-20 bulbs and medium-bipost bases (trade designations 300T20/2 and 500T20/4) indicate that such lamps show only small variation of candlepower *vs.* angle of either tilt or rotation about a vertical axis. This variation was less than 1 per cent for changes of angle of 10 degrees about either axis (±5 degrees from the perpendicular to the filament plane, which was taken to be in the plane of the base pins).

Inside frosted lamps have not previously been used as candlepower standards, presumably because of the large size of source and the uncertainty

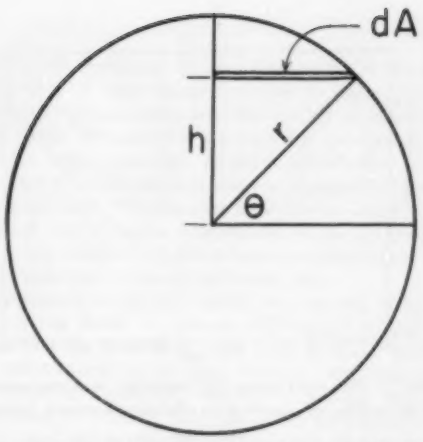


Figure 6. Element of area displaced at an angle Φ from the horizontal as viewed from the lamp filament.

of the point in the lamp from which the photometric distances should be measured. Preliminary measurements on the change of apparent candlepower of the lamps with change of distance from the receiver indicate that the inverse square law may be used for distances of 50 centimeters and greater without introducing errors of as much as 1 per cent, the distances being measured from the plane of the base pins to the receiver. The errors found in these preliminary measurements were, in general, of the opposite sign from those predicted by assuming that the lamps are cylindrical sources.

Steps have already been taken to have 100-watt lamps of the same type made up as photometric standards. It is possible that by the time this paper is presented, 100-, 300-, and 500-watt lamps of this type, specially made as photometric standards, will be issued as standards of candlepower in lieu of the clear-bulb lamps previously issued.

In connection with the use of clear-bulb coiled-filament lamps as standards of candlepower, it should be noted that the measured candlepower will not be independent of the vertical angle subtended by the receiver at the filament since the luminous intensity of such lamps varies so markedly with vertical angle. Assuming a circular receiver of radius, r, we see by referring to Fig. 6 that the luminous flux, F, received is:

$$F = 4\int_{h=0}^{h=r} E\,dA = 4\int_0^r E\,r\cos\theta\,dh$$

where:

E is the illumination on the element of area dA,

h is the distance of dA from the center of the receiver.

Since:

$h = r\sin\theta$

$dh = r\cos\theta\,d\theta$, and

$$F = 4\int_0^{\pi/2} E\,r^2\cos^2\theta\,d\theta.$$

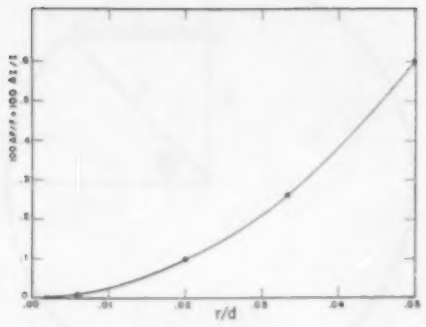


Figure 7. Per cent error of intensity measurements vs. ratio of radius of receiver to distance between lamp and receiver.

Since $E = KI$, where K is a constant and I the luminous intensity of the lamp in the direction dA, and since from previous discussion of the properties of these lamps it is evident that I can be expressed as:

$$I = I_o\,[1 - 0.05\,(1 - \cos 20\Phi)],$$

where I_o is the maximum luminous intensity and Φ is the angular displacement of dA from the horizontal as viewed from the lamp filament, it follows that:

$$F = 4KI_o \int_0^{\pi/2} [1 - 0.05\,(1 - \cos 20\Phi)]\, r^2 \cos^2\theta\, d\theta$$

$$= 4KI_o r^2\,[\pi/4 - 0.05 \int_0^{\pi/2} (1 - \cos 20\Phi) \cos^2\theta d\theta].$$

The per cent difference between the flux incident on the receiver when I does not vary with Φ, and the flux when I does vary with Φ in accordance with the above relationship is given by:

$$100\Delta F/F = \frac{20}{\pi} \int_0^{\pi/2} (1 - \cos 20\Phi) \cos^2\theta d\theta.$$

Since $\tan\Phi = \dfrac{h}{d} = \dfrac{r\sin\theta}{d}$, where d is the distance from lamp to receiver, the indicated integration can be made by a summation process for any assumed value of r/d. This was done for five values of r/d, from .002 to .05, and the results obtained are plotted in Fig. 7. It will be noted that for the maximum plotted value of r/d, where the distance from lamp to receiver is 20 times the receiver radius or 10 times the receiver diameter, the error introduced is 0.6 per cent which is a minor error compared to that introduced by tilting the lamp.

In view of the deficiencies of clear-bulb, coiled-filament lamps as standards of luminous intensity, their use, except possibly in special applications, should be avoided wherever possible. Recommended as replacements, if maintenance measurements prove them suitably stable, are inside-frosted lamps similar to the 300- and 500-watt lamps referred to above. These lamps, in addition to the advantage of relative uniformity of candlepower with change of angle cited above, will have a medium-bipost base instead of the screw base now used on nearly all candlepower standards. The medium-bipost base will enable the user of such standards to orient his socket properly at the start of a series of measurements and relieve him of the necessity of orienting each standard individually. In addition, the use of a diaphragm in front of the standard, which has been a great inconvenience, will be eliminated. The frosted-bulb lamps will have two fiducial marks: one to show which side of the bipin plane faces the photometer, the second to show the vertical position of the filament center so that this position can be placed in the horizontal plane through the photometric axis.

References

1. Middleton, W. E. Knowles and Mayo, Eleanor G.: *Journal of the Optical Society of America*, 41, 513 (1951).
2. Barbrow, L. E.: *Journal of Research*, National Bureau of Standards, 25. 703 (1940) RP1348.

DISCUSSION

C. F. KOENIG:* Mr. Barbrow and I have discussed this subject several times, particularly because of the variations which we have encountered from time to time in trying to obtain reproducible measurements on lamps of this type.

While Mr. Barbrow was conducting his experiments, he called them to our attention and we were prompted to make a similar series of measurements. These were made on both clear and inside frost lamps, with and without limiting diaphragm, and invariably we encountered the same condition as that outlined in the paper. Consequently, we have decided to adopt the procedure referred to as Step 2, *i.e.*, we intend to eliminate the diaphragm and use frosted T-bulb lamps with bi-post bases for our basic horizontal candlepower standards as quickly as possible.

W. E. K. MIDDLETON:** I wish to congratulate the authors of this paper on an extremely useful piece of work. I suppose that the reason Miss Mayo and I did not investigate the intensity distribution in a vertical plane in 1951 was that we were primarily interested in the carbon standard lamps used as secondary standards where this is not so important. This probably colored our thinking and that is why we did not do the vertical distribution on the lamps with coiled filaments.

Much experience with photographic sensitometers in our laboratory has shown that coiled filament lamps suffer from this defect, and in fact, we have for some time sandblasted the outside of the bulbs of numbers of these lamps for use in sensitometers. Quite recent measurements by P. D. Carman have yielded results similar to those reported in the present paper. It now appears that we should obtain inside frosted lamps for this use and also for use as standards of luminous intensity. It would be interesting to know

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whether these inside frosted lamps with medium bi-pin bases are actually available commercially, or whether the entire operation is special.

There is a further question that I should like to ask regarding the use of frosted lamps as intensity standards. Just what portion of the lamps is the distance measured from? In the case of the clear lamp, the distance is, of course, measured from the plane of the filament, but with the frosted lamp, a good deal of the light would come from positions closer to the receiver and I do not believe that it would be correct to measure from the axis of the lamp. This trouble does not arise, of course, when such lamps are used in a sensitometer because the distance from the lamp to the film plane is always fixed.

S. M. Gray:* The characteristic cyclic or banded candlepower distribution in a plane passing through the axis of a straight coiled filament has created problems in several applications of clear bulb lamps. E. W. Beggs described the phenomenon as exhibited by phototube exciter lamps and the improvement effected by use of a curved helical filament instead of the conventional straight coil.[1]

Problems arising from the same cause have been encountered in color motion picture printers and in slide projectors, the effects consisting of faint horizontal dark bands at equal distances above and below the center of the picture. This effect may be reduced substantially or eliminated by any of several measures which may be taken in the construction of the lamp filament. Two methods which have been suggested are:

(1) Tilt the segments of a multi-segment filament alternately forward and backward by an angle equal to one-half of the segment's pitch angle of the coil. In this way, the candlepower peaks of half the segments and be made coincident with the candlepower valleys of the remaining segments, thus creating a substantial improvement in the uniformity of the over-all candlepower distribution.

(2) Coil the filament with a variation of pitch, either from segment to segment or from end to end of each segment. No clearly defined cycle should then appear in the over-all candlepower distribution because of the variable pitch angles of the individual turns.

1. Beggs, E. W.: *Journal of the Optical Society of America*, March 1939, p. 123.

E. H. Salter and W. F. Little:** For many years we have recommended against the use of candlepower standards in projection lamps rated at less than 500 watts. This recommendation was based on the fact that the field produced by these lamps appears streaked and at the shorter photometric distances used for the smaller lamps these streaks are apparent. Also, these smaller lamps tend to blacken earlier when operated at 2854 K. At this point, it should be pointed out that standards to operate at 2400 K normally would be supplied as vacuum lamps rather than gas-filled lamps as covered by this paper.

Arrangements for the photometry of candlepower standards have not provided any appreciable orientation of the vertical axis of the lamp, and lamps have been specially selected for straightness in the base and the filament mount. Within all these limits, it has been possible to make assignments and to replace the lamp in its lampholder so that variations in indicated candlepower have in general been within ±0.5 per cent.

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Messrs. Barbrow and Wilson's explanation of the streaks in the field of these lamps, referred to above, has been recognized for some years, with the result that lamps with a single helical filament have been avoided for this use. This has been quite noticeable in automotive lamps, where a single bar filament does not make a satisfactory standard, while those with "V" filaments have been acceptable. They point out that a similar condition exists for all projection type lamps, though no difficulty had been experienced in our case in assigning values on the larger sizes.

As suggested by Barbrow and Wilson, one way of handling this problem would be through the use of fiducial lines etched into the glass bulb some fixed distance above the photometric center of the lamp filament. We agree to this as a practical suggestion, although it appears likely that some means of marking the lamp would have to be worked out so that the marks could be applied to the lamp as mounted in the photometer.

This paper suggests the use of inside-frosted candlepower standards as the most feasible means of eliminating the possible vertical alignment error. Such a possibility has been considered at other times but discarded due to the difficulty of seeing the filament condition. Standard lamps normally are selected lamps in which the filament is straight, well located and supported in such a manner that it is unlikely to shift in service or in normal handling. However, it is not unusual to find, especially after shipment, that rough handling has distorted the supports and in some cases the filament. Frosting the bulb would make it more difficult to see this distortion and it has been considered undesirable since it has been felt that such a condition might unknowingly seriously change the calibration of the standard.

It also is surprising to learn that with a frosted-bulb candlepower standard the filament remains the photometric center even though the frosting serves to eliminate the streaks due to filament structure. It would appear that the photometric center should be shifted closer to the near surface of the frosted envelope. However, we have no data to support this.

L. E. Barbrow and S. W. Wilson:* We are thankful to Mr. Koenig for his verification of the data reported in our paper and also for his cooperation in undertaking the development of 100-, 300-, and 500-watt inside-frosted lamps, specially constructed as photometric standards. We anticipate receiving these lamps soon, after which we plan to season and calibrate them promptly so that this new type of photometric standard may be made available as soon as possible to those who desire to have them.

Relative to Dr. Middleton's remarks, we can say that 300- and 500-watt inside-frosted lamps of the type described in the paper are commercially available. However, for use as photometric standards, we are having lamps of those two wattages, as well as 100-watt lamps, made specially. For the time being we suggest, as pointed out in the paper, that photometric distances be measured from the plane which bisects the lamp base pins. Preliminary measurements indicate that the frosted lamps, when so used, follow the inverse square law as well as clear bulbs do with photometric distances measured to the plane of the filament. We plan to investigate this matter further when we receive the specially constructed photometric standards referred to above. Dr. Middleton remarks that a good deal of light comes from positions closer to the receiver. Insofar as the bulb is a good diffuser, the change of area of bulb viewed by the receiver, as the distance between lamp and receiver is

*Authors.

changed, tends to balance this effect. Remaining, however, is the effect of elongated distances of those portions of the bulb which are removed from the light center of the lamp along the bulb axis. This effect is opposite in direction to that cited by Dr. Middleton and would tend to place the photometric center of the lamp at a point further than the lamp axis.

Mr. Gray's comments are most interesting. It is unfortunate that photometricians over such a long period of time have not related to their standard lamps the exciter lamp data in the 1939 reference cited by Mr. Gray. The methods for reducing the cyclic effect described by Mr. Gray do not appear to be either as effective or as practicable as the use of frosted lamps.

We will discuss the joint comments of Messrs. Salter and Little in the order in which they presented them. As reported in our paper, 500-watt lamps are no better, and indeed appear to be worse than the smaller sizes of lamps with respect to variation of candlepower in a vertical plane. The standards in question are intended for use well above 2400 K, and usually at 2854 K.

The obtaining of variations of candlepower within ± 0.5 per cent without appreciable care in orienting the vertical axis of gas-filled standards cited by Messrs. Salter and Little appears to be fortuitous in view of the data reported in our paper.

We regret that over a long period of time we were similarly under the impression that we had not experienced the type of difficulty reported in our paper.

We tried the use of fiducial lines at a specified distance above the photometric axis. Our experience, substantiated by Mr. Koenig and his colleagues before they decided to go over to the use of inside-frosted lamp standards (see his comments above) has led us to the conclusion that this is not a practicable solution of the problem.

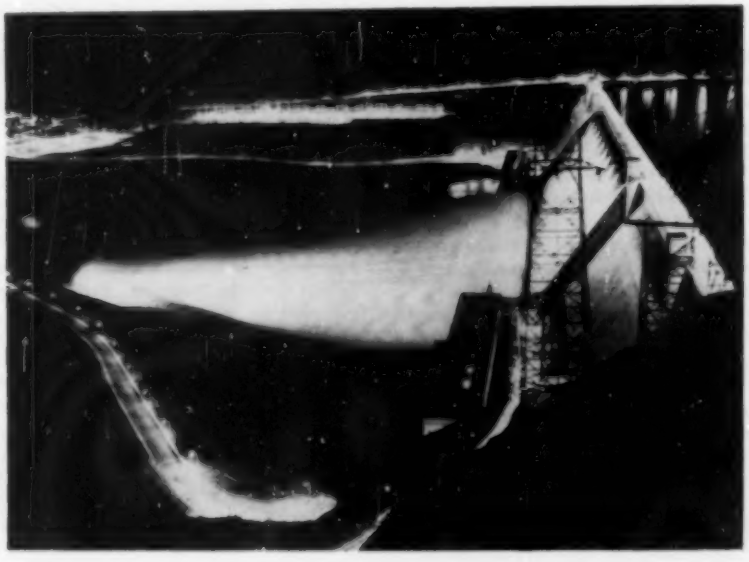
The difficulties cited in the next to last paragraph of the Salter-Little comments appear to apply to standards of luminous flux as well as to standards of luminous intensity. Nevertheless, frosted lamps have been used successfully for years as standards of luminous flux. The use of a pin hole to cast a shadow of the filament has proved to be adequate in the case of frosted luminous flux standards to examine the orientation of the filament and the filament supports and should be similarly adequate for the frosted luminous intensity standards.

As noted above, it cannot be assumed that the photometric center of the frosted T-bulb lamp should be closer to the near surface of the bulb.

Floodlighting Grand Coulee Dam

Representatives of the regional tourist association of the Grand Coulee Dam area are hoping it will rival Niagara Falls as a tourist attraction, with a floodlighting color display using 742 wide-beam 1500-watt floods in white, yellow, red, blue and green. The system provides an uninterrupted 30-minute display on the waters which tumble over the dam from Lake Roosevelt into the Columbia River 350 feet below. Color changes occur every 12½ seconds. The bank of floodlights is 90 feet wide and 20 feet high. When all lights are on, the averag. maintained illumination is 3-4 footcandles. Approximately 1250 kilowatts are required.

Photo, taken from the left switchyard of the dam, courtesy U. S. Bureau of Reclamation.



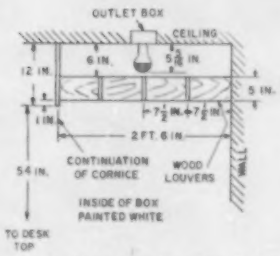


Figure 2. Section showing louvered box.

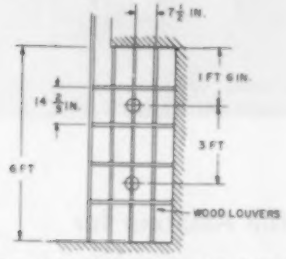


Figure 3. Plan of louvered box.

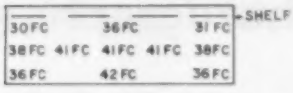


Figure 4. Illumination distribution on desk top.

INSTALLATION IN HOME OF MR. AND MRS. JOHN O. STODART, BARREN HILL, PA.

Custom Lighting for a Built-In Desk

LIGHTING OBJECTIVE: To provide reading light on desk and decorative illumination on shelves and bookbindings for a contemporary arrangement of desk and wall shelves.

GENERAL INFORMATION: The desk area shown above is six feet long. Woodwork is bleached mahogany (40% RF), and the wall (above the shelves) and ceiling are matte white (80% RF).

INSTALLATION: Figs. 2 and 3 show the spacing of two porcelain sockets with silvered-bowl lamps, mounted above the wooden louvers. Fig. 4 shows the resultant illumination on desk top with new 150-watt silvered-bowl lamps. (The 200-watt size can be substituted if additional illumination is desired.) The 150-watt lamps give an average of 37 footcandles over the entire desk top, with about 40 footcandles at the front area. Vertical illumination on book bindings is about 28 footcandles. The louver immediately under a lamp has a brightness of 100 footlamberts (measured at a 45-degree angle); the back wall, above the shelves, has a brightness of about 40 footlamberts.

Lighting designed by Elizabeth A. Meehan, Lighting and Wiring Specialist, Philadelphia Electric Co.

Lighting data submitted by Elizabeth A. Meehan as one solution to a lighting problem and to aid in the design of similar installations.

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MMILJ entries and many other lighting installations may be photographed by novices—given a few instructions. In this article, the author has shared her experience in taking lighting pictures with commonly available cameras. Her suggestions have purposely been kept simple, and are directed only to the amateur. Fine points of technique have been left to the professional.

Figure 1. Photograph taken with flash or photoflood. This procedure washes out the lighting effect.

Suggestions to the Amateur for

Photographing

ONE OF THE best sales tools available to the lighting engineer or salesman is a good photograph of a lighting installation. One good photograph can show lighting effects better than a thousand words. In many areas, however, commercial photographers experienced in this special type of photography are hard to find, and are usually expensive. Within certain limitations, photographs of lighting installations can be taken easily by an amateur, with inexpensive equipment.

A lighting photograph differs from others in that supplementary light such as a flash or photoflood cannot be used because it washes out the effect of the lighting system. Therefore, the lighting photograph must be taken as a time exposure. Figs. 1 and 2 compare a flash photograph and a time exposure of the same subject. The "flashed" photo, Fig. 1, shows no effect of the garden lighting, although this was operating at the time the photograph was taken. Notice, however, that the time exposure, Fig. 2, shows lighting and gives greater feeling of depth and realism.

This article will outline one of the simplest approaches to this procedure. When the basic fundamentals have been mastered and greater proficiency is desired, it is suggested that a study be made of excellent previous articles on the subject by Tom Knowles (ILLUMINATING ENGINEERING, July 1952 and June 1954) and by Willard Allphin (ILLUMINATING ENGINEERING, December 1953).

Camera

Most of the 35 mm cameras in common use for color transparencies are good for this type of work. Most other cameras can be used provided they have a variable shutter to accommodate more or less light. It is necessary that the camera have a time setting which is usually indicated on the scale by a "T" or in some cases "B." With the camera set on "T" and using a cable release, the first plunge opens the shutter and a second plunge closes it. On a camera that has no "T," set speed on "B" and use a special cable that locks the shutter open until it is released.

In order to hold the camera steady during the long time exposure, it is necessary to use a tripod. A small inexpensive tripod can be used satisfactorily. However, if it is to be used frequently, one with more adjustments, such as height, angle, etc., is more convenient.

Film

If the lighting photographs are to be used primarily when talking directly with a customer, or for oral presentations such as the My Most Interesting Lighting Job contest, the most suitable film would be colored film which is developed directly into transparencies, such as Eastman Kodachrome Type A, Ektachrome Type B, or Super Anscochrome. Any of these films are suitable for photographing installations using incandescent illumi-

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Figure 2. Same scene as Fig. 1 taken with time exposure; no supplementary lighting used. Note difference in effective demonstration of lighting effect. For a direct light reading of 2 footcandles, exposure was 45 seconds at *f*/8 on Kodachrome Type A, ASA-12.

Lighting Installations

By RUTH PATTERSON MADDOX

nation or deluxe cool white or home-line fluorescent. To photograph installations using any of the other fluorescent lamps, filters should be used as recommended by Mr. Allphin in his article published in the December 1953 ILLUMINATING ENGINEERING. If the photographs are to be used for printed reproductions, the negative should be at least 4 by 5 inches rather than 35 mm. Suitable black and white film would be fast film such as Eastman Tri-X or Super Ansco Hypan.

Meter

In order to arrive at correct exposure settings, a photographic meter is needed which reads down to two or three footcandles. Suitable meters are General Electric #DW-68, or the new Norwood Super Director.

Procedure

With the camera mounted on tripod, the scene to be photographed is sighted in the view finder. In a small room it is often difficult to back away from the subject far enough to take a sufficient portion of it in the picture. This can be improved by the use of a wide angle lens. The normal 35 mm lens covers approximately an angle of 45 degrees, and most wide angle lenses cover 63 degrees. Even without the wide angle lens, certain tricks can be

Figure 3. Ornate door was positioned to create light and shadow. 150-watt recessed fixture and walls of 40 per cent reflectance gave direct light reading of 6 footcandles at this close range. Exposure is 30 seconds at *f*/11, Kodachrome Type A film.

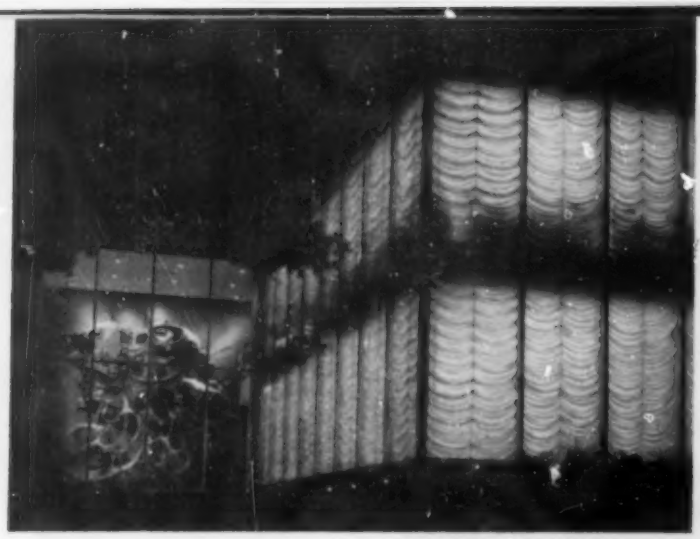

Figure 4. Although luminous ceilings gave 90-footcandle level inside these attractive offices, the reading from across the street was 2 footcandles. Exposure is 15 seconds at *f*/4 on Kodachrome Type A film.

Figure 5. Fluorescent valances provide indirect illumination for this living room. Direct light reading of 4.5 footcandles called for an exposure of 20 seconds at *f*/8 on Kodachrome Type A.

Figure 6. With dark brown walls, floor and ceiling, the 900 watts in wall-washing fixtures gave a direct light reading of only 3 footcandles. Exposure is 30 seconds at *f*/8, Kodachrome Type A.

Figure 7. (left). Floodlighted Christmas scene scarcely gave a readable light level, but the figures were well lighted. Average light was estimated to be 1 footcandle. Exposure is 100 seconds at *f*/8, Kodachrome Type A.

Figure 8. (below). Wall display lighting gave direct reading of 10 footcandles. Exposure is 70 seconds at *f*/22 with Kodachrome Type A film.

learned that will help with this problem. Turning a 35 mm camera on its side so that the wide part of the picture is vertical will usually make it possible to include both floor and ceiling in the view. In a home it is sometimes possible to use a mirror to increase your distance from a subject.

After the camera position is determined, a measurement of the light should be made. There are two types of light readings which can be made — direct light and incident light. It is suggested that the amateur use the direct light method. This is done by holding the meter within a few feet of the camera, aiming at the subject. A number of readings are taken, and an average found for the view to be photographed. The meter is set for the speed film being used (this is given in the instructions which are included with each roll of film). For the light level found, a corresponding lens opening and time may be read on the meter.

As an example, in Fig. 2 the reading was two footcandles. Using Kodachrome Type A film with a speed of 12, the lens was set at *f*/8 and exposed for 45 seconds. A watch with a second hand is needed for accurate timing. On a faster black and

Figure 9. High intensity altar lighting gave a direct light reading of 10 footcandles. In order to get greater depth of focus, 35-second exposure was given at *f*/16 lens opening, Kodachrome Type A film.

Figure 10. Luminous ceiling in a display room gave an average illumination of 50 footcandles. Direct light reading was 25 footcandles, so the photograph was taken at *f*/16 with 15-second exposure.

white film such as Super Ansco Hypan with a film speed of 500, the lens could be set at *f*/22 and exposed for 10 seconds.

Composition is an important aspect of photography. The entrance hall of Fig. 3 is made more attractive by looking from the outside into the room. The handsome exterior in Fig. 4 is made more dramatic by shooting from an angle and by framing with a tree limb across the top.

Figs. 5 and 6 show two living rooms of different character. In Fig. 5 fluorescent valances wash the light-colored walls with a soft diffused illumination. The lighting in Fig. 6 consisted of six 150-watt R40 floodlamps in recessed wall-washing fixtures. These give a hard light which produces sharp shadows and bright highlight, and makes a photograph of high contrast and sharp detail.

In scenes of high contrast such as Figs. 7 and 8 the exposure should be chosen to use as small a lens opening and as long an exposure as practical. This helps to keep some of the grays in the picture instead of just black and white. Also scenes of greater depth, such as Figs. 9 or 10, should use a small lens opening. This makes for sharper focus over the range of close-up to distance. The floodlighted building of Fig. 11 could be taken with a larger lens opening and hence a shorter exposure since the subject matter is almost all the same distance from the camera.

It is suggested that two or three pictures be taken of each scene after the equipment is all set. Film is fairly cheap, but duplicates are expensive and not too satisfactory. It is also suggested that the beginner make a record of the footcandle reading, exposure and lens setting used for each picture. After the film is developed he can compare his results with the reading and settings used and know in what direction to improve his work.

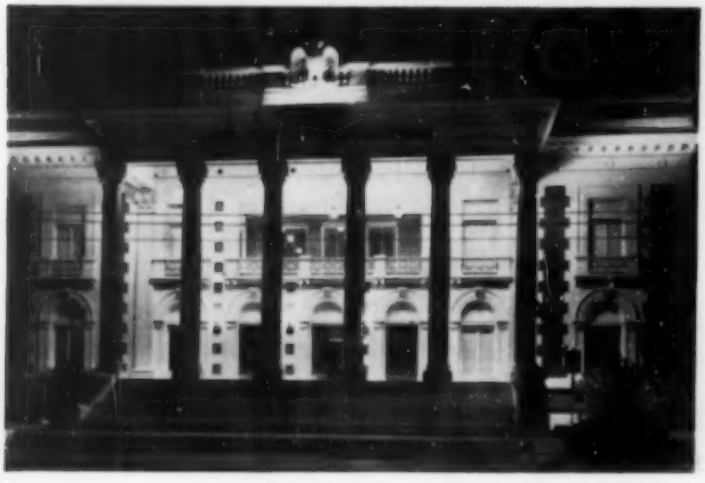

Figure 11. Brightly lighted building with light-colored surfaces had direct light reading of 2 footcandles. Exposure is 12 seconds at *f*/4.

New Combustible for Photoflash Lamps

By L. F. ANDERSON

The development steps toward the attainment of the new zirconium photoflash lamps are described, including theoretical considerations, preparation of materials and test program. Reasons for selection of zirconium are given, and the somewhat involved processing of zirconium into suitable raw material for photoflash is outlined. The advantages of zirconium, as well as the advantages obtained from the particular designs selected, are discussed. Performance characteristics including light output, timing, color temperature and reflector efficiency are described and illustrated. Reasons for choosing the rated peak times specified, as well as other ratings, are discussed. Photographic significance of this development is set forth.

A CASUAL consideration of the source of radiant energy in expendable photoflash lamps reveals that it is derived from heat of combustion. The source is principally incandescent matter in all three phases, although the gas phase predominates.[1] Although exothermic chemical reactions provided the earliest means of artificial illumination, and approximately 25 per cent of all present illuminants fall into this category, it seems to be of only fleeting interest to most illuminating engineers. Perhaps this is due to the lack of versatility in application, apparent simplicity, or, more likely, a dearth of papers on the subject. It is hoped that the following will serve as one step toward rectifying the last condition.

In essence, a photoflash lamp is merely a fire in a bottle, as shown in Fig. 1. The combustible is metal in powder, foil, or filamentary form. The combustion supporting means is oxygen, a readily reduced oxide, or may be other reactive gases. The igniter is an electrically initiated match. A fine tungsten filament is heated to incandescence and ignites primer beads applied to lead wire junctions. A violent heat stream from the primer then ignites the combustible mass.

The first practical photoflash lamps were filled with aluminum foil about 0.00002-inch thick, and an oyxgen atmosphere of about 15 cm Hg in a bulb about the size of present 150-watt incandescent lamps. Volumetric efficiency was approximately 170 lumen seconds per cubic centimeter. Luminous efficiency, determined from theoretical heat of formation, was approximately 18 lpw

$$\left(\frac{\text{lumen second output}}{4.185 \times \text{caloric output}}\right).$$

Status of Existing Lamps

Developments in the aluminum-oxygen lamp, photographic equipment and film have proceeded at a rapid pace since 1930. The extent to which this lamp has met the basic requirements of photographers is covered in the following items:

1. *Miniaturization*—Although great strides have been made in speed of film and lenses, substantial size reduction was possible only by increasing volumetric efficiency. Nearly a seven-fold increase has been achieved mainly by stronger envelopes, better fill dispersion, and improved igniters. No. 5 and No. 25 lamps yield about 750 lumen seconds per cubic centimeter, while the M2 gives over 1000 lumen seconds per cc. Additional improvement in the miniature lamp was still needed for high speed and color photography.

2. *Maximum Utilization and Uniformity*—High speed synchronization of Class M lamps (20 milli-

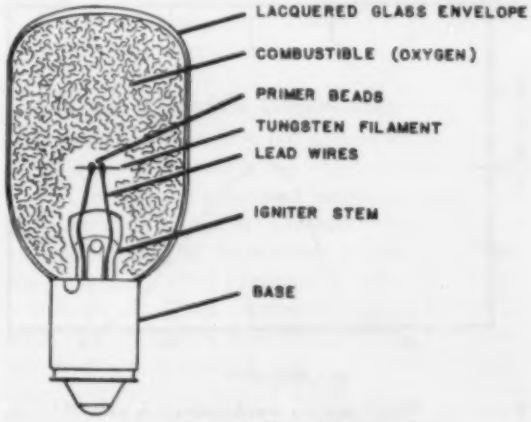

Figure 1. Typical flash lamp parts.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, August 17-22, 1958, Toronto, Ont.
AUTHOR: Sylvania Electric Products Inc., Montoursville, Pa.
This paper accepted by the Papers Committee of I.E.S. as a Transaction of the Illuminating Engineering Society.

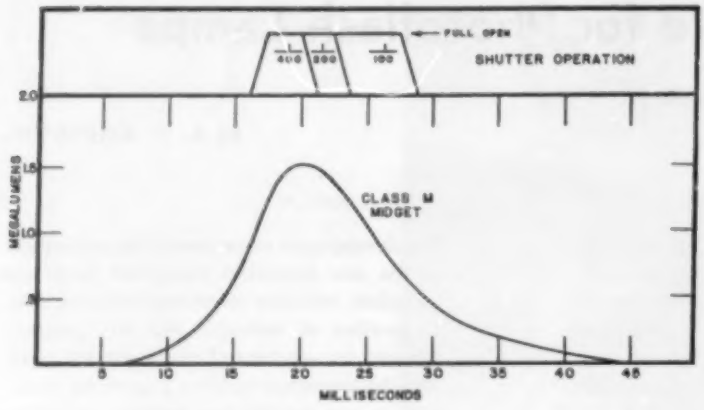

Figure 2. High speed camera synchronization with Class M type lamps.

second peak time as shown in Fig. 2) has been reasonably satisfactory with closely controlled filamentary fills and igniters, coupled with more precise timing of synchronizers. However, the relatively limited latitude of color film warrants even closer timing control, particularly at higher shutter speeds. The rated peak time and short duration of the miniature M2 (15 milliseconds peak time as shown in Fig. 3) is designed for box cameras and does not give acceptable results with high shutter speeds. Likewise, Class M lamps give limited utilization with inexpensive, fixed focus cameras when the shutter closes in 1/50th second.

3. *Acceptable Color Balance* — Filters, in the form of lens attachments or incorporated in bulb coating, have given reasonably good results with tungsten color film, rated at 3200K or 3400K. Clear or light filter coated lamps are used successfully with Type F color film, which is balanced to 3800K, the approximate color temperature of most photoflash lamps. A relatively dense blue filter, incorporated in bulb coating, has given acceptable results with daylight color film. Blue miniature M2B lamps, however, are only partially compensated to daylight because of light output limitations, and results are poor unless used as fill-in illumination.

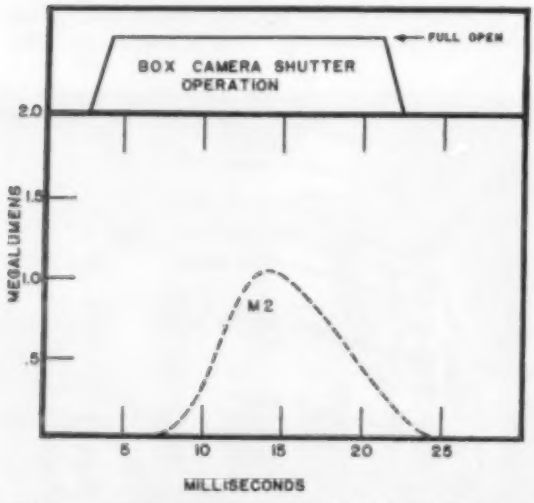

Figure 3. "Box" camera synchronization with M2 type lamps.

4. *Low Ignition Energy with Minimum Inadvertent Flashes* — Ignition energy levels of early lamps were reasonably satisfactory and improvements have been made since then. Small, dry cell batteries, coupled with intermittent wiping contacts, limit input energy to less than 5 milliwatt seconds. Nevertheless, the photoflash igniter is amply sensitive providing equipment is properly designed and maintained. Provision for low ignition energy requirements tends to increase susceptibility to inadvertent ignitions. Therefore, flashes may occur due to energy from static discharges, microwave fields, and friction. However, improved primer application and internal grounding have reduced the probable frequency of such flashes to less than 1 per 100,000, even in cold dry weather.

5. *Rapid, Positive Insertion and Removal* — Latching devices and semi-automatic ejectors facilitate loading and removal. The miniature lamp base, requiring no orientation, simplifies loading and has led to magazine feed.

6. *Containment of Reaction within Envelope* — Despite increases in oxygen pressure and volumetric efficiency, better containment has been realized through improvements in igniter and fill uniformity, small bulb size, and stronger interior and exterior coatings.

7. *Low Cost* — Substantial cost reductions have been made along with advancements through design changes and automation. Twenty years ago, the retail cost of comparable illumination was nearly double existing cost, and the lamps were greatly

inferior in uniformity and applicability. In real value, this represents more than 75 per cent cost reduction.

These developments satisfied most of the major requirements, but even prior to 1950, the limitations of the aluminum-oxygen system were recognized. Further increase in volumetric efficiency appeared to be limited and were contingent upon smaller and stronger envelopes. No substantial increase in luminous efficiency had been made, nor was any predictable. A new system offered the only frontier.

Only two departures from the aluminum-oxygen system had ever been made commercially. The first was a 5 per cent to 7 per cent magnesium alloyed aluminum wire, which served to improve ductility and lower ignition temperature. Little change in luminous efficiency, compared to pure aluminum, was noted. The second is the zirconium primer paste lamps, SF and SM, which have very low volumetric and luminous efficiencies of approximately 170 lumen seconds per cubic centimeter and 9 lpw, respectively. However, the lamp has some very useful properties. The color temperature is approximately 3300 K, which is an acceptable match for indoor color film. Rapid energy development to an early peak, coupled with short duration, obviates the necessity for elaborate shutter delay mechanisms, and provides fairly short exposure time even at slow shutter speeds. Despite these applications, the potential of zirconium as a photoflash combustible was obscured by the very low efficiencies.

Experimental and Thermodynamic Considerations

Early in the development program it was apparent that accurate appraisals of new systems could not be made with materials in powder form because of the inability to obtain good dispersion. Also, the difficulty in obtaining applicable elements in thin foil or filamentary form precluded the possibility of making random selections. Therefore, it was decided to make detailed thermodynamic calculations for all likely candidates among the elements. Those reactions that appeared to be superior to the aluminum-oxygen system were tested experimentally, where possible. The accuracy of these calculations was greatly enhanced through declassification of Atomic Energy Commission data and techniques.[2]

In an effort to break through the limitations of the aluminum-oxygen system, many costly, scarce and uncontrollable reactants, such as uranium, thorium, cerium and fluorine, were investigated. The following factors were found to most greatly influence the color temperature and luminous efficiency.

1. *Heat of Formation* — If the total heat developed were merely used to raise the temperature, this might be the only major consideration.

2. *Decomposition Temperature* — This was the most important criterion for predicting color temperature, light output and peak pressure. When decomposition into sub-compounds or original reactants occurs at relatively low temperatures, some of the heat of formation will be used to dissociate the final compound, instead of raising the temperature. A peak equilibrium temperature can be calculated from a statistical evaluation of temperatures, dissociations and pressures.

3. *Reaction Speed* — Reaction becomes less adiabatic with decrease in speed. If reaction speed is slow, more heat will be dissipated by conduction, and temperature will not be increased as predicted.

4. *Selective Radiation* — Spectral emissivity of the evolved compound, along with radiation lines and absorption bands of activated gases, will affect the approximate assigned color temperature and photographic actinicity.

5. *Absorption* — Depending on the system, various percentages of radiant energy will be absorbed by the reactants and compounds formed.

Verifications of the predictions made from the thermodynamic data and the effects of other factors, not covered in these calculations, were determined experimentally by testing reactants in lamps. Many systems were ruled out, either thermodynamically or experimentally, notably including thorium, uranium, titanium and magnesium-oxygen systems and all the metal-halogen systems. The zirconium-oxygen system yielded the highest efficiencies and the thorium-oxygen system was the closest second. Of equal importance in the final selection was the subsequently warranted belief that zirconium would ultimately become available, and that processing into filamentary combustible could be done at reasonable cost.

Processing Zirconium Combustible

Obtaining satisfactory foil proved to be a formidable task. Hardness is the chief obstacle to successful rolling and shredding into filamentary combustible. The hardness increases with cold work and percentage of impurities, particularly small amounts of absorbed oxygen and nitrogen.[3] Iodide refinement of Kroll processed sponge results in more uniformly pure zirconium, but sizes of crystal bar produced were small and costs high. Furthermore, ultimate foil was no softer, probably due to absorption of gases in subsequent operations.

Therefore, Kroll processed, reactor grade zir-

conium was used. The sponge is arc melted into ingots and forged into desired shape. It is then hot-rolled to a thickness of approximately 0.100-inch. At this point it is vapor blasted, pickled and annealed. Subsequently, it is rough rolled to sheet form and finally precision rolled to specified foil gage of 0.001-inch or less. Frequent interruptions for annealing are necessary to relieve cold work stresses. Very high vacuum must be maintained to minimize absorption of oxygen and nitrogen. Rolling techniques and vacuum annealing schedules are vital to production of satisfactory foil. The foil, which is 4 to 8 inches wide, is then sliced into filamentary strips 0.0010-inch to 0.0015-inch wide. If the material is harder than 200 DPH, it will tear, break, or form excessive powder.

Reactor grade zirconium is preferred. Lower efficiencies have been obtained with commercial grade, containing Hafnium, and with zircalloy.

Thus, highly acceptable combustible has been attained, but costs are high. The zirconium fill in M25 or M5 lamps is more than 200 times the cost of aluminum in an M2 lamp. Nevertheless, the lamp cost is nearly competitive from the standpoint of subject illumination. Although foil costs are currently higher than original estimates, due to unanticipated complexities and tighter tolerances, it is still expected that increased usage in reactor and other fields will permit substantial reductions within the next few years.

Advantages in the Zirconium-Oxygen System Compared to the Aluminum-Oxygen System

The following advantages have been obtained:

1. *Higher Luminous Efficiency* — The luminous efficiency of the zirconium-oxygen system is approximately 36 lpw. This is due primarily to higher decomposition temperature, although other factors such as burning rate, selective radiation and reduced absorption also contribute. Approximated color temperature is only 150K higher.

2. *Reduced Bulb Heating* — Inasmuch as radiation is only fractionally absorbed, the total heat dissipated in the bulb is approximately 25 per cent lower per unit weight of oxygen consumed.

3. *Lower Peak Pressures* — Peak pressure is more than 30 per cent lower per unit weight of oxygen consumed. This results from higher decomposition temperature, in that fewer gas molecules are present to expand. Reduced thermal energy at the bulb surface and reduced peak pressures permit increasing the initial oxygen pressure in the zirconium lamp by more than 25 per cent. Nevertheless, peak pressure and total thermal energy at the bulb surface are slightly less compared to the most efficient aluminum lamp.

4. *Improved Timing Uniformity* — Variations in cross section of zirconium strands and energy output of the igniter have less effect on burning characteristic due to lower ignition temperature.

5. *Broader Intensity-Time Characteristic* — For the same peak time and rate of energy increase the duration is longer. This is probably due to the higher peak temperature and the rate at which relatively compact zirconium oxide cools. This is particularly useful in high speed synchronization as exposure will be more uniform.

6. *Reduction in Susceptibility to Inadvertent Ignitions* — The zirconium lamp is only about 50 per cent as susceptible to inadvertent ignitions from microwave fields and static discharges as the aluminum lamp. This is due to higher initial fill pressures and better grounding through the zirconium fill.

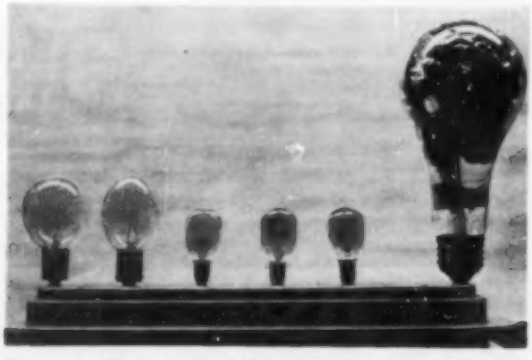

Figure 4. Physical comparison of midget, miniature and foil lamps.

Photographic Performance

Four zirconium lamp types have now been manufactured: M25, M25B, M5, and M5B. The M25 types have nominal peak time ratings of 15 milliseconds, which are designed for so-called "box" cameras. The M5 types are designed to peak at 20 milliseconds, and are adapted to high speed, Class M synchronization.

Fig. 4 shows a physical comparison of the bayonet based midget lamps, #25 and #5, three miniature lamps, M2, M25, and M5, and a rather ancient foil lamp, #20, in that order. The miniature lamps appear to be nearly identical except for the somewhat darker color of the zirconium fill in the latter two. The volumes of the midget lamps, at the left, are 31 cc and 25 cc, respectively. The three miniature lamps range in volume from 6.7-7.3 cc. The total light output of the zirconium lamps is 16,000 lumen seconds, compared to an average of about 19,000 lumen seconds for the midget lamps. Minia-

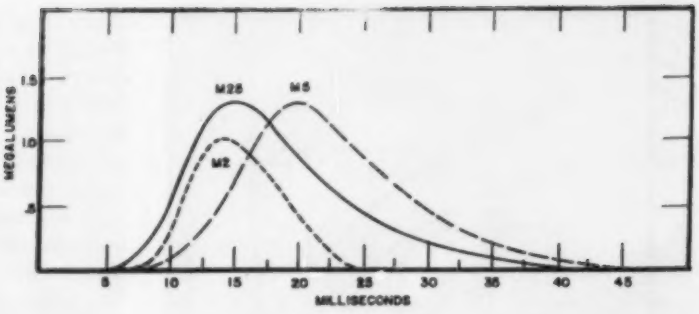

Figure 5. Time-intensity characteristics of M2, M25 and M5 miniature lamps.

ture lamps are used in very efficient 3-inch reflectors, while midget lamps are used in 4- to 5-inch reflectors, most of which have somewhat lower efficiencies of redirection. Reflector factors,[4] which are a weighted average of illumination with reflector compared to bare lamp illumination, give an average advantage of approximately 15 per cent for the miniature lamp combination. Therefore it follows that the zirconium lamps, having one-quarter the volume of midget lamps, provide nearly equivalent subject illumination. Likewise, considering the relatively poor efficiency of large lamps used in 7-inch reflectors, the zirconium miniature lamp is nearly equivalent in subject illumination to the long discontinued #20 foil lamp, shown at the extreme right.

Fig. 5 shows comparative intensity-time characteristics of the M2, M25 and M5 lamps. Total light outputs are 7,000 lumen seconds for the M2 lamp, and 16,000 lumen seconds for the two zirconium lamps.

Fig. 6 shows a comparison of effective lumen seconds for M5 and Class M midget lamps, as seen through a high speed synchronized shutter at 1/100th second, 1/200th second, and 1/400th second. Deviations from normal timing of shutter opening or from rated photoflash peak time are given along the abscissa in milliseconds. Positive values indicate early shutter opening or late photoflash peak time, *i.e.*, shutter leads peak time. Negative values indicate late shutter opening or early photoflash peak time, *i.e.*, shutter lags peak time. The average level of the M5 is less than 10 per cent below that of the Class M midget lamps. However, it will be noted that better uniformity of exposure is obtained with the M5, particularly near the center of the range. The ±5 milliseconds range approaches 3 sigma limits provided synchronizer setting is reasonably accurate.

Fig. 7 shows a comparison of effective lumen seconds, for M2, M25, and Class M midget lamps, as seen through "box" camera shutters. Prevailing average shutter closure time is 25 milliseconds. Curves for the M2, M25 and Class M midget lamps show effective light *vs.* peak time variation for nominal shutter closure of 25 milliseconds. The solid part of the curve extends 4 milliseconds either side of the rated peak time and gives approximate ranges (16 ms to 24 ms for the 20 ms midget, and 11 ms to 19 ms for the 15 ms M2 and M25). The average exposure of midget lamps, and likewise of 20 millisecond zirconium lamps, is higher than that of an M2, but variability is likely to be much greater.

X and *F* synchronization[5] can also be covered in Fig. 7. At *X* synchronization, the shutter opens approximately 2 milliseconds prior to energizing the lamp. At *F* synchronization, the shutter starts to open at the same time the lamp is energized. At 1/50th-second shutter speed, approximate closure times would be 18 (20−2) and 21 (20+1) milliseconds, respectively. Average effective light outputs for miniatures may be found at the 19- and 16-millisecond ordinates, respectively. At these settings, the highest practical shutter speeds for the

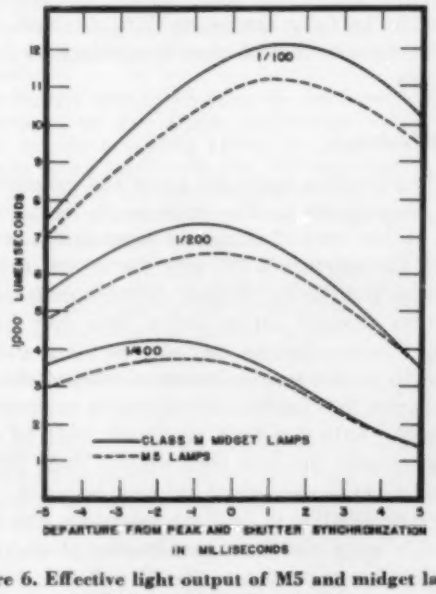

Figure 6. Effective light output of M5 and midget lamps for high speed synchronization.

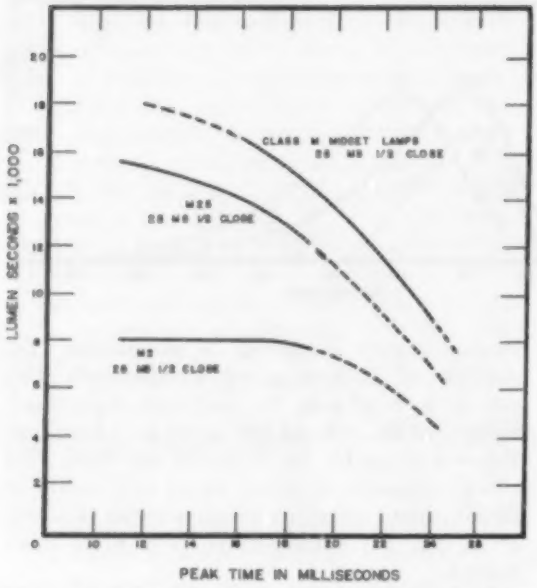

Figure 7. Effective light output of M25, M2 and midget lamps for "box" camera synchronization.

M25 lamps are 1/50th second to 1/60th second, and much better utilization is obtained at slower speeds.

An amber filter coating is applied to the M5 and M25 to reduce the color temperature, inasmuch as F type color film is balanced to 3800K. The M5B and M25B have a blue filter coating to raise the color temperature to approximately 6000K, the color temperature to which daylight color film is balanced. These blue lamps are the first miniature types to be fully compensated to daylight. The light output rating of these lamps is 8500 lumen seconds.

Conclusion

The zirconium lamps are a new and valuable tool for photographers. The increase in light output will enable users of miniature based lamps to close down the aperture a full stop for increased depth of focus and clarity. Higher shutter speeds may be used to "freeze" action better than ever before. Larger group pictures may now be taken and distance to subject may be increased when desired. A whole new field has been opened up in color. Where formerly, only threshold exposures could be made at acceptable distances from subject, fully exposed transparencies and prints can now be made. With full compensation to daylight, miniature blue types provide many additional uses in color photography.

Virtual equivalence to the #5 and #25, bayonet based midget lamps, has been attained, and the vastly improved portability of the zirconium lamps should be very advantageous. For years, many camera manufacturers have complained about the "tail wagging the dog," referring to the comparative size of flash equipment to the camera. The new lamps will enable many manufacturers to reduce the size of flash equipment substantially.

In conclusion, this development is regarded as the most significant advancement in the 28 years of photoflash history. It is the first time that substantial improvement in luminous efficiency has been made, and volumetric efficiency increase to 2100 lumen seconds per cc is greater than combined improvement of previous history.

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DISCUSSION

R. F. VANDENBOOM:* Economic considerations generally have prevented most illuminating engineers from specifying footcandle levels which would provide optimum visual acuity. As a result, we often find ourselves assuming that more light is necessarily desirable. However, with a given set of conditions, this simply is not true in the photographic field. Take the "box" camera, for example. Perfect exposure occurs at 7 feet using either standard type F transparency or negative type color film and an M2 lamp. Doubling the light output results in perfect exposure at 10 feet instead of seven feet. This is fine if a 10-foot shot is desired. But, if as is often the case, the photographer prefers to move in to 7 feet in order to obtain a larger, clearer picture of his subject, he may be plagued with serious over-exposure.

The real question, it would seem, is at what distance from the subject do most "box" camera owners prefer to take pictures. To determine this, more than 50,000 prints were inspected at a typical photo finishing plant. These were black and white prints from box cameras. The latitude of black and white film is so great, plus the additional control in printing, that acceptable prints can be made from box camera exposures from 5 to 20 feet. Therefore, it could be

TABLE I — Per Cent Flash Exposures Made at Various Distances — Black and White Films, Box Cameras.

Distance in Feet	Per Cent of Flash Pictures	Distance in Feet	Per Cent of Flash Pictures
2	2	12	4
3	8	13	4
4	10	14	4
5	13	15	3
6	10	16	3
7	8	17	3
8	6	18	2
9	6	19	2
10	5	20	1
11	5	Over 20	2

*Photo Lamp Department, General Electric Co., Cleveland, Ohio.

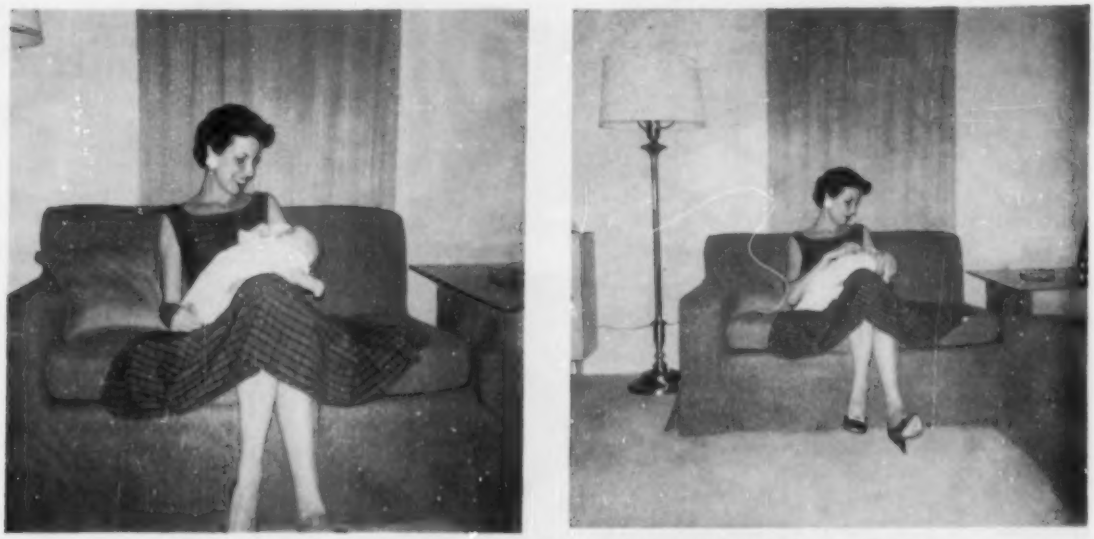


Figure 1. Typical box camera subject photographed at distances of seven (left) and ten feet with a Kodak Starflash camera.

assumed that these pictures were taken at the distance the photographer preferred rather than at the distance dictated by the film-flashbulb combination. Results of this survey are shown in Table I. Notice that 50 per cent of all exposures were made at a distance of 7 feet or less. A glance at Fig. 1, showing a typical shot taken at 7 feet and 10 feet shows why.

Does it not appear, therefore, that the M2 lamp when used with color film in box cameras will produce more satisfactory results for more people than will the zirconium lamps? In addition, the M2 offers greatest economy to the photographer (11¢ vs. 14¢ for M5 or M25).

Since the M2 can be used from 5 feet to 20 feet with black and white film, the need for more light is even less here than with color film. Nearly 90 per cent of all box camera exposures are still made with black and white material.

Zirconium lamps, therefore, appear to fill a need for less than one per cent of all exposures in the box camera field. Even here, our tests indicate the performance of the M5 is comparable to the M25. In these tests, shutter performance was measured on all box cameras now on the market. The average time, after electrical contact, for the shutter to reach the half-closed position was found to be 25+ milliseconds in cameras designed for miniature flashbulbs. Thus, while the M25 produces 12,700 lumen seconds while the shutter is open, the M5 produces 11,200 lumen seconds. Stated in more practical terms, optimum exposure using standard Type F color film occurs at 10.7 feet using the M25 and 10 feet using the M5.

Simplicity is important to most box camera owners. The added simplicity of standardizing on one photoflash lamp type also seems desirable. In that event, it appears that the M2 is still the best all around lamp for the box camera — both for performance and economy.

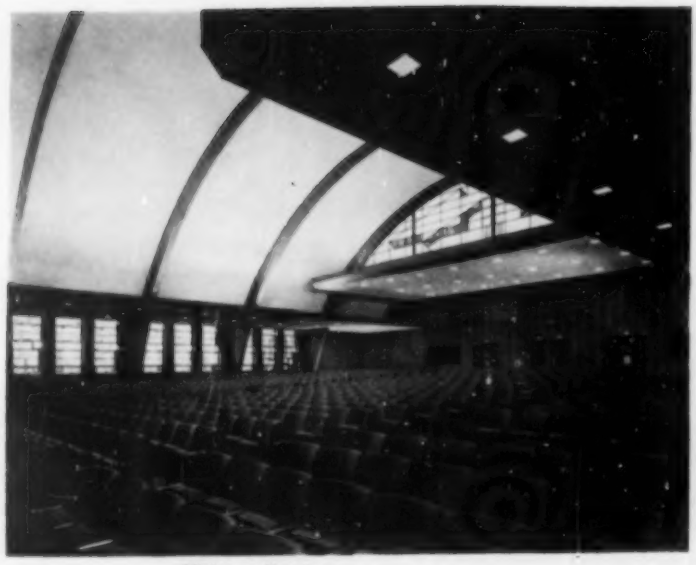
Mr. Anderson stresses the importance of miniaturization in photography in general and photoflash lamps in particular. We most heartily agree. The miniaturization in the form of the M5 lamp as a replacement for the No. 5 and No. 25 appears to be a really significant contribution made possible by the use of zirconium.

L. F. ANDERSON:* To cover the range of requirements, it is obvious that there are definite applications for both the M2 and the M25 in box camera photography. Using the percentages cited in Mr. Vandenboom's Table I, M2's give satisfactory color photographs for 30 per cent of the population at the recommended distances of 6 to 9 feet. Similarly, M25's give satisfactory results for 26 per cent of the population, at the recommended distances of 8 to 12 feet. Certainly these miniature lamp users should not be denied color shots beyond 9 feet. Our own analyses indicate that under-exposure, rather than over-exposure has been the greatest problem for the box camera user, and to some extent, this may be a factor in the relatively low percentage of color used with box cameras. Where over-exposure is a problem, attenuation may be easily effected through lens filters, diffusing shields, or removal of reflector, if one does not choose to carry a less powerful lamp. No means for increasing illumination are available to the box camera photographer.

For daylight color photography, the box camera user is operating at an even greater disadvantage without the M25B. In order to partially satisfy this requirement, prior to the zirconium lamp development, the lamp industry provided an abortive, partially compensated M2B in which it was necessary to compromise on color balance to achieve bare threshold exposure.

In box camera application, the M25 is far superior to the M5. It is true that the average effective light output as seen through a shutter that is half closed in 25 milliseconds, is only about 15 per cent greater for the M25 compared to the M5. However, there is no comparison in uniformity of exposure. Assuming a peak time spread of ±4 milliseconds, as indicated in Fig. 7, the effective light output range is 2:1 for the M5, compared to 1.3:1 for the M25. For faster closure time and for "X" or "F" synchronization at 1/50th-second shutter speed, the comparison is even more favorable to the M25. In these cases, average effective light output of the M25 may be 50 per cent greater than that of the M5, and the spread less than half as great.

*Author.



Main auditorium.

National Entry Class II

Simplicity Economy Suitability:

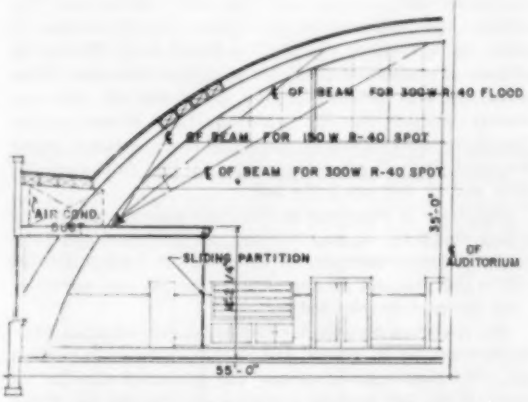
LIGHT as a structural element of architectural design frequently finds its best expression in religious interiors. It has been so used in this beautiful Synagogue of Congregation Rodfei Zedek. These could be only words, however, without the engineering detail which forms the other half of the partnership of the "art and science of lighting." It is this phase which Mr. Cohen presents as his most interesting achievement. Adding to his challenge was, of course, the problem so often encountered in such jobs — budget limitations.

Main Auditorium

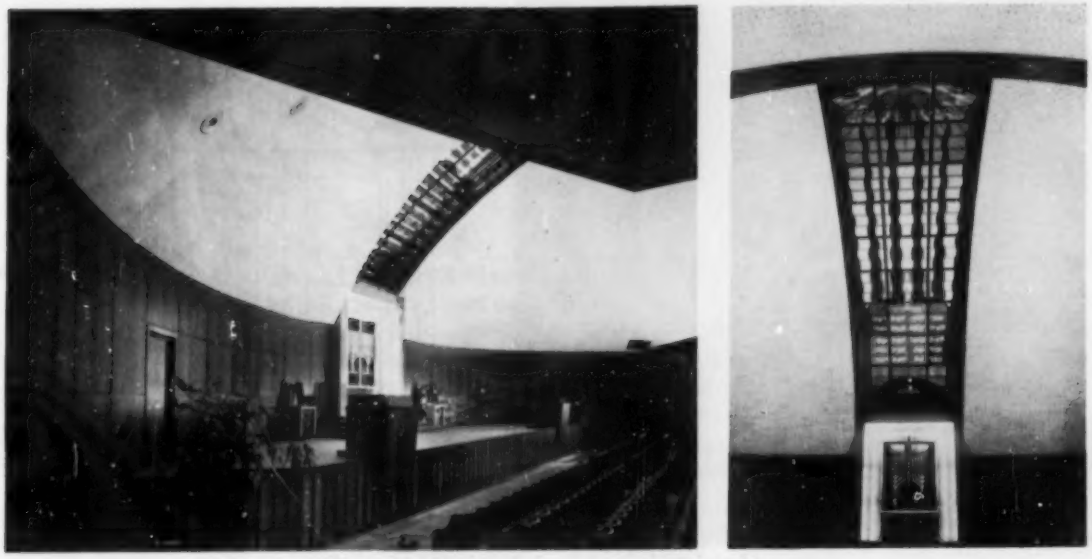
The main auditorium is 110 feet wide and 100 feet long, with a seating capacity of 1250. It is used for the High Holiday services and large social functions. The space beneath the canopies on each side is also used as classrooms, partitioned into 20-foot-square sections by means of sliding curtains. The room is richly decorated with redwood laminated arches on 20-foot centers, redwood wall paneling and a patterned acoustical tile ceiling. Ceiling reflection factor is 72 per cent, paneling is 22 per cent and the carpeting 15 per cent.

Incandescent was chosen for the general illumination for color rendition and the R-40 lamp for economy. Cove lighting was selected as being less costly than chandeliers (which would also detract from the simple architectural lines of the room) and more easily maintained than a system recessed in the 35-foot high ceiling, for which a catwalk would have to be constructed. The side canopies provided an obvious location for the installation of the R-40 lamps; 150-watt on 3-foot centers, 300-watt on 1½-foot centers and 300-watt on 3-foot centers. These are mounted in swivel sockets which are secured to a continuous metal raceway, mounted on the platforms at each side from which the units can be relamped.

Since the lamps burn only about 300 hours a year, the reflector lamp has an economic advantage


℄ OF BEAM FOR 300W R-40 FLOOD
℄ OF BEAM FOR 150 W R-40 SPOT
℄ OF BEAM FOR 300W R-40 SPOT
AIR COND. DUCT
35'-0"
SLIDING PARTITION
℄ OF AUDITORIUM
55'-0"

R-40 lamps mounted on the 14-foot 2¼-inch high platforms on either side of the main auditorium.



Altar area of main auditorium, with stained glass window.

Specifications for a Synagogue

over a PS-30 in a metal reflector, although it is higher in initial cost. It would take 25 years to offset the initial cost of metal reflectors.

Illumination at the front or pulpit area is supplemented by recessed adjustable fixtures, with 200-watt lamps, mounted in the band shell ceiling. Two of these units on each side are aimed at the speakers' positions. In addition, the number of R-40 cove lights is doubled in this area. Illumination on the pulpit area was 45 footcandles and that in the general auditorium was 25 footcandles after one year's operation.

The Ark which houses the Holy Torahs (Scrolls) is highlighted by a single lamp cove. This provides 100 footcandles, focusing attention on the Ark. Over the Ark is a stained glass window depicting the burning of the Ten Commandments at Mount Sinai. The flame portion at the top is lighted by ten 150-watt PAR-38 spotlamps behind the glass. The remaining area is illuminated by 24 rows of slimline lamps on 24-inch centers. Each row contains two 72-inch lamps on 430 ma. Since the stained glass has a high transmission factor, vinyl sheets are placed between the stained glass and the lamps, and for a gradually diminishing brightness from top to bottom, two thicknesses of plastic are used: 0.007- and 0.020-inch, for brightnesses of 65 footlamberts at the flame and 25 at the Ten Commandments.

Lighting in the areas under the side canopies is from recessed square units with concave low-brightness lenses and 150-watt lamps. These units are spaced on 7-foot centers and provide 35 footcandles after one year's service.

Units in the platform at the rear of the auditorium are 15-inch square fixtures with low brightness lenses and 200-watt lamps. Ceiling height here is 20 feet and the units provide 20 footcandles in this area.

Chapel

The 1000-square-foot Chapel, which seats 112, is used for Friday Evening services and small social affairs. General illumination is provided by four

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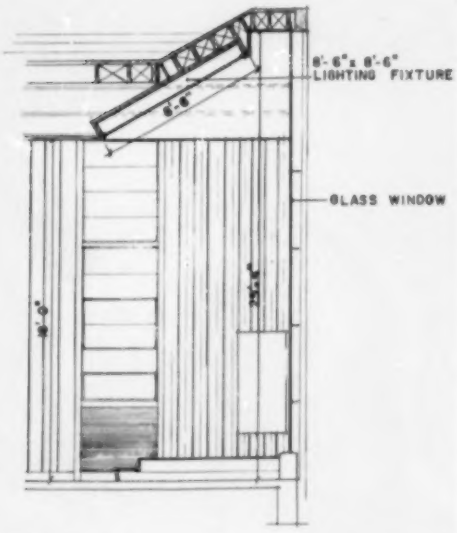
Melvin Cohen, *Chicago Section, Midwestern Region, won top honors in his Regional contest for My Most Interesting Lighting Job, with this installation. Mr. Cohen is an Illuminating Engineer with A. Epstein and Sons, Engineers and Architects, in Chicago, Ill.*



Chapel, with specially designed "light boxes."

chandeliers, each containing eight 60-watt lamps in the arms and three 100-watt lamps in the center globe. Chandeliers are placed on either side of the center aisle, so as not to distract from the main altar. Chandeliers provided 20 footcandles after one year's operation.

The altar is illuminated by both incandescent and fluorescent sources. Two recessed adjustable fixtures use 150-watt PAR-38 floods, and two lighting "boxes" each contain 96-inch T-12 slimline lamps operated at 430 ma. These "boxes" are mounted at an angle in front of the translucent glass windows on each side of the altar and serve two purposes. They add more light to the altar area and also illuminate the glass panels which form part of the main facade of the building. The translucent glass will be replaced with stained glass as soon as the money is available. Illumination on the altar area from both incandescent and fluorescent fixtures totals 40 footcandles — twice the level in the rest of the room.

Lobby

The entrance lobby is 1300 square feet in area and is lighted by a combination of sources. Incandescent units are used to dramatize a marble wall opposite the main entrance doors, supplemented by a fluorescent cove adjacent to the wall. PAR-38 spots highlight shrubbery at the foot of the wall.

Especially designed rectangular fluorescent fixtures, with 2- by 4-foot diffusing glass panels, are used elsewhere in the lobby for a level of 25 footcandles after one year's service.

Results

The three criteria for the specification of lighting in this Synagogue can be considered as met. The dramatic and functional results achieved and the harmony of lighting system with the architecture are shown in the photographs. The third factor, economy, is evident only to those responsible for the Congregation's finances.

Index to 1958— Officer-Committee Directory

The annual Index to 1958, which will be published as Part II of the January 1959 issue, will give the business addresses, when available, of IES Officers and committee personnel for 1957-1958 and 1958-1959, and so can be used as a Directory for these active IES members.

Automated Universal Distribution Photometer

By J. STUART FRANKLIN

PAUDGET, the subject of this paper, is defined "Photometer, Automated Universal Distribution Gonio Electric Type." To meet present-day needs of photometric testing[3,7] this fully automated distribution photometer was born. Since the advent of fluorescent lighting, measurement requirements have necessitated a new approach to luminaire testing. Lamps are sensitive to changes in operating position, to ambient temperature, to thermal drafts; and their very size prohibits their being properly tested on previously available types of photometers. Several different types of photometers have been and are being used, but they all have inherent serious drawbacks to their continued use. The time required to manually take the hundreds of readings, make necessary corrections during test, make temperature corrections at the completion of a test, calculate, and plot the data is prohibitive in today's business climate. A large, fully automated photometer, capable of operating all luminaires in their normal "in use" position, at any required test distance, at a standardized ambient temperature with minimum thermal drafts, was our selection. Equipment necessary to the realization of these goals is now technically and economically available.

Basic Requirements

Listed below are the major requirements for PAUDGET:

(1) It should be capable of making distribution measurements of any existing or foreseeable street light, floodlight, or lamp and of mounting searchlights for normal outdoor testing.

(2) It should be capable of mounting luminaires in their normal operating position.

(3) It should be capable of measurements at any distance up to 100 feet on an indoor range and up to over 1500 feet on an outdoor range.

(4) It should operate in standard ambient temperature of 77F ±2F with minimum thermal drafts.[11]

(5) The centerline of light beam must be fixed in space and not vary with luminaire or photometer position.

(6) Both goniometer Types[1] "A" and "B" should be present or possible.

(7) All foreseeable luminaire power requirements should be provided.

(8) All electrical and mechanical devices necessary for personnel safety should be provided.

(9) It should have a rapid means of changing from one setup to another, thus minimizing photometer set-up time.

(10) Fully automatic operation ("Auto" in text) requiring no human attention during test should be provided.

(11) It should have an extremely simple, versatile, foolproof method of programming.

(12) It should have sufficient output data automatically punched into tabulating cards to permit mechanized and electronic calculation of test data with existing or future electronic data processing equipment.

(13) Testing and calculation time should be a matter of minutes instead of hours.

(14) Accuracy of any angular measurement should be within ±0.5 degree, and electrical readout should be within 0.3 per cent of full scale.

(15) There should be no requirements or provision for curve plotting.

(16) To eliminate all linearity errors, a multirange visual and digital indicator of the current balance type is required for light measurements.

(17) Manual as well as automatically operated electrical drives are required on all axes of rotation.

(18) Provisions should be made for operating with various types of brightness meters, and long persistent screen cathode ray oscilloscopes.

(19) It should have unified control panels for simplified operation.

(20) It should provide for the possibility, when advanced types of electronic computers become available in the Department, of automatically plotting iso-candle, iso-footlambert, and iso-footcandle curves.

(21) It should have provision for taking output data in such type and form that visibility and comfort calculations can be made from basic test data without further data handling.

(22) It should have a well balanced photometer structure, very sturdily constructed, yet requiring the minimum in electrical drive requirements.

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TABLE I — Statistics.

1. *Luminaires and lamps that can be tested*
Types: Any lamp, streetlight, floodlight or searchlight.
Sizes: Lamps and luminaires up to 9 feet in length.
Projectors up to 36 inches in diameter.
Operating Position: Any normal service condition.

2. *Structure*
Overall Size: 10-foot by 16-foot diamond shaped frames, 15 feet wide, rotating on two 8.7-foot diameter rings.
Mirror Size: 8-sided, 8-foot by 12-foot by ¼-inch thick "Parallel-o-Plate" glass. Second surface silvered glass mirror.
Weight: Approximately 7.5 tons.
Elevation Centerline: 5 feet 9½ inches above floor of laboratory.
Goniometer Types: Both "A" and "B" types possible.

3. *Space Requirements*
Room Size for Structure: 23 feet long by 15 feet wide by 24 feet high.
Ranges Available: Indoor — 100 feet long.
Outdoor — 1500 feet + long.

4. *Electrical*
Wire Installed: Approximately 1¼ miles.
Control Power Needed: Approximately 4 kw.
Luminaire Power Normally Available: Approximately 10 kw.
Types of Power Available: D-c—a-c 60 and 400 cps, 1 and 3 phase — voltages up to 600 volts.
Readout Recorder: Multi-range current balance type.
Input-Output Device: Electro-mechanical card punch.

5. *Accuracy*
Angle Setting: ±0.5 degree.
Electrical Readout: 0.3 per cent.
Analog to Digital Converter: 0.1 per cent.

6. *General*
Room Ambient Temperature: 77 F ± 2 F.
Position and Readout Time: Approximately 0.06 minutes per reading.
Drawings Required: Approximately 100.
Planning and Design Stage: Approximately two years.
Construction Time: Approximately one year.

(23) The floor space should be the minimum consistent with the above requirements.

(24) There should be a bright, cheerful control room environment for laboratory personnel.

As one might guess after reading these two dozen major requirements, the laboratory has been designed for and around PAUDGET. Table I gives statistics on the final design. Fig. 1 gives a pictorial view of the various major components, and a block diagram showing its elementary functional operation. Input and output information is in the form of tabulating cards, read and punched on an electro-mechanical card machine. Information read from cards is sent to the program unit, which is the "brain" of the system, co-ordinating all functions. The program unit positions the fixture in azimuth (fixture rotation) and the ferris-wheel-type structure in elevation (structure rotation on the large rings). The light output is read, by the light read-out device, into the card machine and the data punched into the final tabulating card.

The design of PAUDGET, in which the luminaire revolves around a mirror,[2] was selected as being most suitable for our purposes. The basic construction is shown pictorially in Fig. 1, and actual details are shown in Figs. 2 and 3. Two large, diamond-shaped frames support two steel rings, approximately 8½ feet in diameter, which ride on four small idler and drive wheels. These assembled frames and rings are spaced twelve feet apart by a structural steel connecting frame that forms the support for an 8-foot by 12-foot silvered glass mirror. This mirror is mounted at a 45-degree angle to the axis of the rings and midway between the two rings. The two ends on the long axis of the diamond-shaped frame support a yoke for mounting the luminaire and, on the opposite end, counterweights to balance the weight of the luminaire yoke. To keep the structure in balance, provision is made on the counterweight side for adding weight, depending upon the weight of the luminaire being tested. As the rings rotate, the mirror, luminaire yoke, and counterweights also rotate. The mirror simply rotates about its mounting axis while the luminaire and counterweights trace a circular path in space. To make certain the luminaire always operates in the required mounting position, the luminaire yoke on the structure is pivoted at each end, and provided with counterweights, which maintain the vertical position of the yoke in its traverse of space about the centrally located mirror.

This type of construction has four main advantages: (a) it is a type "A" goniometer, (b) luminaires may be mounted in their normal operating position, (c) tests can be made at any distance because of the reflected light beam always occupying the same line in space, and (d) it uses a compact, well-balanced structure.

Its basic size and complexity was determined by the requirement for testing fluorescent luminaires up to over eight feet in length and in operating positions up to 25-degree tilts above the horizontal.

By means of an auxiliary yoke (see Fig. 4) one can easily convert to projector testing and employ a type "B" goniometer.[1] In this case, structure elevation is locked in fixed position, the floodlight yoke is mounted on the structure in place of the luminaire (shown in Fig. 2), and the floodlight mounted within the square holder (see Fig. 4) which can then be rotated in azimuth and elevation. For testing searchlights, PUADGET is used only as a means of support and for supplying power. Tests would be

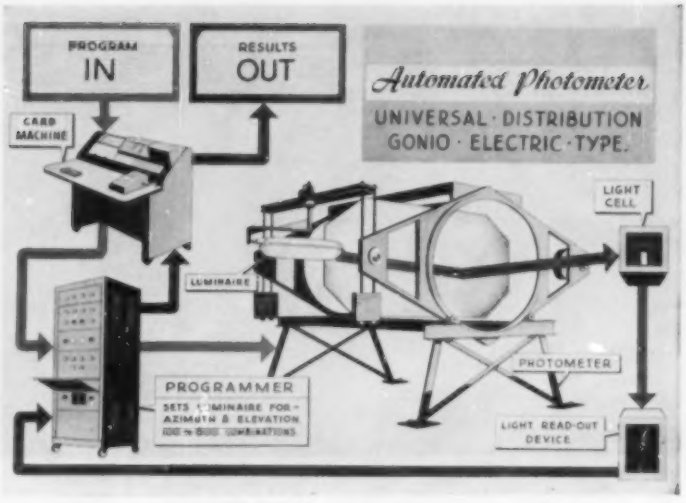

Figure 1. Functional Diagram. By following the arrows, the path of the input information on cards can be traced through the card reader tand program unit, to the photometer structure drive motors. Light output from the luminaire is measured by the light cell, sent to the light readout device, program unit, and to the card machine, where it is punched into the output card.

conducted on an outdoor range, manually, in the usual manner.

Design of Electrical Controls

To make PAUDGET truly automatic and accurate, electrical controls (see Fig. 5) with the following design form were selected.

Servo Drive Circuits

One main objective was to eliminate the laborious hand operation of previous photometers. Three separate electrical drive systems, each capable of being controlled by either manual or automatic operation, were selected.

The high power requirements for the two structure elevation motions necessitated d-c drive motors supplied by a d-c amplidyne with tachometer feedback. The lower power requirements of the luminaire azimuth drive could best be supplied by a two-phase a-c motor operating from a magnetic amplifier, also utilizing tachometer feedback. Maximum speeds of 1 rpm on elevation and 4 rpm on azimuth are possible, with any lower speed available as needed. These were chosen as being maximum safe speeds for structure rotations, while the 4 rpm on azimuth will permit viewing light patterns from luminaires in various cones[9] on a cathode ray oscilloscope.

Visual Shaft Position Indicator

The need for knowing accurately the positions of three shafts operating in space required the use of synchros, a servo amplifier, and a motor driving a three-dial, digital type bearing counter. Thus the operator in the control area knows the exact angular position of all shafts with respect to known reference points. To conserve equipment life, this function is normally inoperative when tests are being run automatically.

Luminaire Power Circuits

A choice of three different circuits is available to supply power to the luminaire under test. Direct current is available for operation of standard lamps and luminaires. Single phase 60-cycle a-c supplies power for luminaire tests. A third circuit has been installed to accommodate 3-phase, 4-wire a-c suplies at various anticipated frequencies and power requirements. On account of the 360-degree rotation of the luminaire azimuth shaft, slip rings are necessary for transferring power to the luminaire. To assure satisfactory operation and long

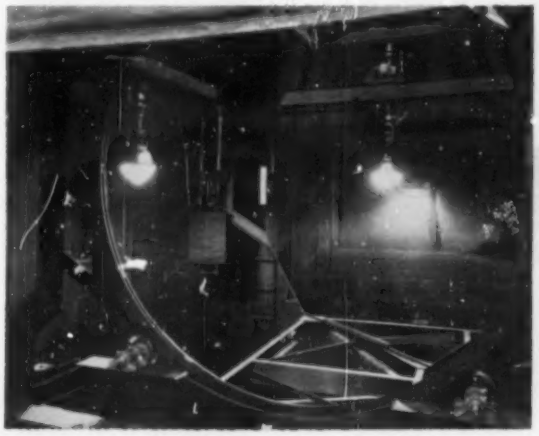

Figure 2. Structure — front view. View taken from point near light cell, looking toward mirror (center) and luminaire (at left). Shows construction details of the frame (foreground) and yoke for mounting luminaire (at left). Window to control area is at left rear.

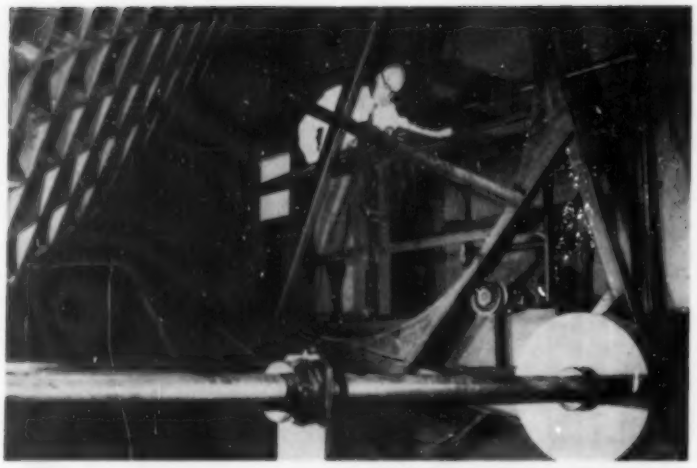

Figure 3. Structure — rear view. View of back of mirror support frame (upper left), counterweights (foreground), and author on catwalk (center). This shows construction details of the supporting frame, cage, and size of structure.

life, silver rings employing three silver graphite brushes per ring have been installed. Adequate provisions for necessary instrumentation have been made.

Control Circuits

Control circuits perform various functions necessary to the proper operation of the photometer and safety of laboratory personnel. There is a main "on-off" circuit for automatic operation, properly interlocked to prevent the taking of incorrect or erroneous test data. There are also the necessary interlocks between circuits, operating switches, time delay relays, limit switches, etc., providing a direct tie-in with the system's program unit.

Digital Readout Circuits

Provision has been made for visually indicating and digitally recording the light output, wattage, voltage, or current of the luminaire. A multi-range current balance type of indicator, having one second balancing time, is employed to eliminate errors due to lack of linearity in circuits employing photovoltaic cells. An electro-mechanical analog to digital converter is geared to the shaft of the indicator, permitting direct digital information to be supplied the program unit. Still to be installed is a potentiometer type of indicator employing a similar analog to digital converter for use in reading luminaire input power, voltage, or current, or room ambient or luminaire temperatures. Various electrical transducers permit selection of function to be measured.

Figure 4. Projector yoke. Laboratory technician holding floodlight to be mounted on a plywood panel within the small square frame (center). Elevation drive mechanism is shown at right. During operation this projector yoke mounts in same location as luminaire shown in Fig. 2.

Master Automatic Input-Output Controls

Two main components make up this section; an electro-mechanical card punch and card reader (see Fig. 6), and an electro-mechanical program unit. Tabulating cards placed in the card machine provide the input and output information. Two interleaved decks of cards are used. One, the master deck, contains a program code number, and the azimuth and elevation angles. At the moment, one reading per card is being used although provisions have been designed into the system to permit five readings per card. The other, or detail deck, contains only the test number, the remainder of the information being punched into it during the test. Such information is either duplicated directly from the master deck, such as the azimuth and elevation angles, or it punches the light and electrical values directly from the analog to digital converters.

Information read from the master cards is fed into the program unit for execution of orders. The program unit controls all photometer operations, calling all the plays. It alone decides if everything is set for automatic operation, calls for reading of card information, positioning structure, punching

Figure 5. Control Area. From left to right are shown the test bench, controlling all power to PAUDGET, the light indicator (top) and motor control cabinet for manual operation of all motor drives (left of center), the master control panel showing controls (top), and program unit at bottom of panel, and in the right rear, the card machine that both reads and punches the tabulating cards.

of readings into cards, advancing cards, stopping operations if something goes wrong, or continuing to function normally until all readings have been completed. It employs a point-by-point positioning system and can be programmed to call for any desired type and number of readout stations simply by changing the input master deck. Extremely versatile programming is possible, and can be changed simply by putting a different deck of master cards in the card punch machine. This feature permits taking light distribution patterns along vertical planes,[9] cones,[9] longitudinal roadway lines,[4] transverse roadway lines,[10] for use in comfort and visibility studies,[6] or along any other desired path.

Operation

A brief explanation of the operation of the electrical system will be given with the aid of Fig. 7.

Luminaire Power Circuits

Regulated a-c or d-c voltages can be selected by the selector switch, to be connected through the necessary instrumentation of the test bench and finally through slip rings to the luminaire under test. A-c control power is also supplied to all control points and is indicated on the block diagram by the use of the circled letters CP.

Digital Readout Circuits

Electrical transducers convert voltage, wattage, temperature, etc., to the appropriate electrical voltages for registering on the indicator shown. In similar fashion, various types of light receivers are employed to convert the luminaire light output to the appropriate electrical currents for registering on the indicator shown. Both indicators employ a direct coupled analog to digital converter which converts the electrical analog signal to an equivalent electrical digital signal for proper registration of the outputs into the output tabulating card by the card punch, the signal arriving there via the program unit.

Power Controls

These are the various interlocking circuits leading up to satisfactory operation of the photometer on automatic operation. Four room door interlocks (lower left of diagram) must be closed before power can be supplied to the luminaire on test or the "auto" circuit energized. At the same time flashing red warning lights about the laboratory call attention of this fact to operating and all other personnel. If the luminaire on test is generating light, a photoelectric light sensor registers that fact and closes another contact in the "auto" circuit. De-

Figure 6. Electro-mechanical card punch. Laboratory technician checking typical output data card. Close-up view of the machine, showing cards in normal operating positions (input, right; output, left), extra program drums (center), hand operated keyboard (right), and typical form of calculated test data (left).

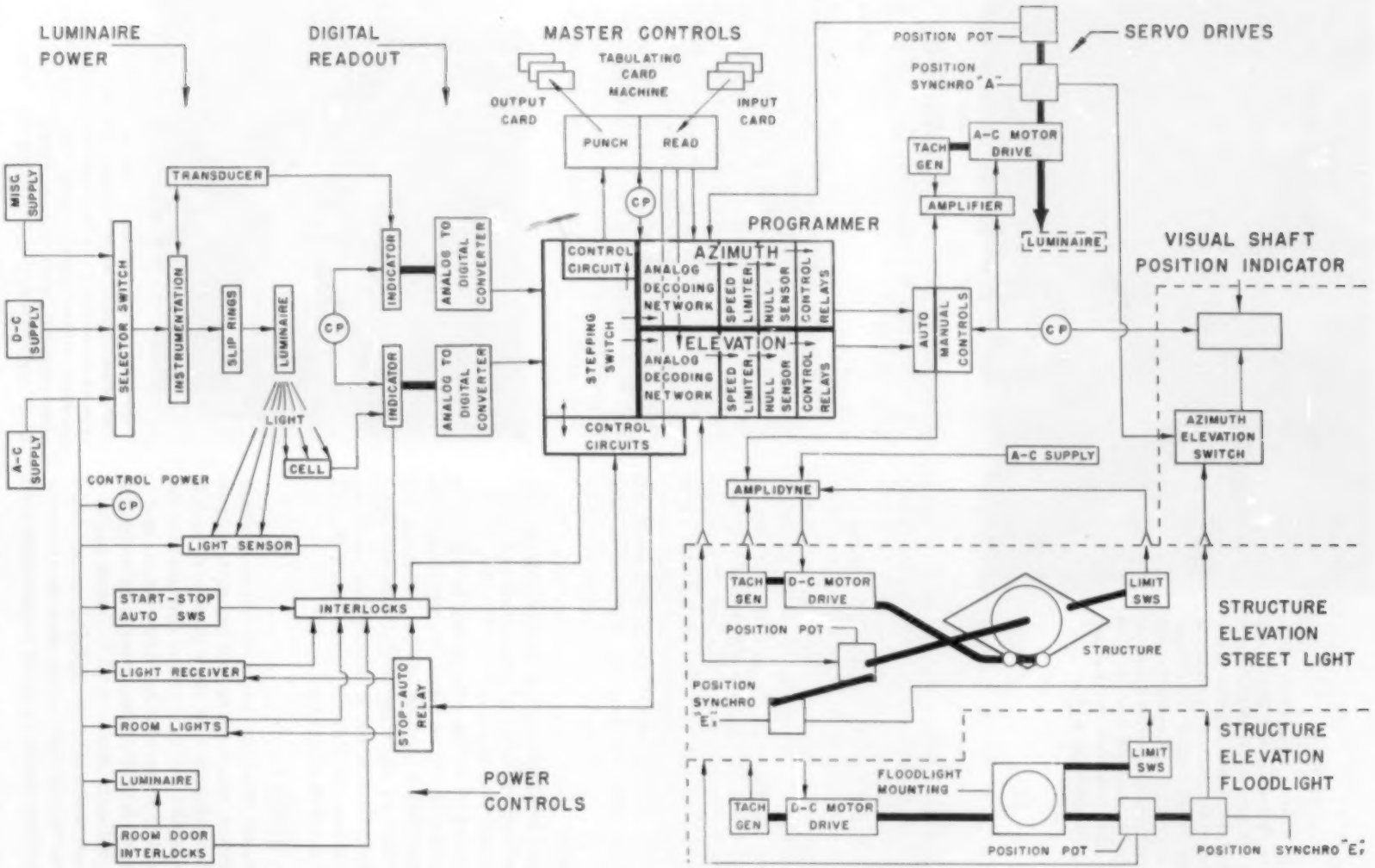

Figure 7. Block Diagram — Electrical System. Here, in block diagram form, one can follow the various paths of electrical signals to and from the program unit (center) and to the input and output cards (top center). The diagram is divided into six major areas for easy reference.

pending upon the test being run, control of appropriate room lights is turned over to the program unit by closing another contact in the "auto" circuit. The proper light receiver circuit scale must be adjusted to the maximum light output expected, after which another contact in the "auto" circuit must be closed. The start push button is pressed and the program unit is then in command. However, if light output from the luminaire should fail, or the light indicator go off scale, or someone should open a room door, or any similarly unauthorized or unexpected act should occur, all operations immediately stop.

Master Controls

The brain of PAUDGET is in the program unit and its tabulating card machine that acts as a master control. The proper deck of interleaved master and detail cards are properly placed and positioned in the electro-mechanical card machine. Upon receipt of the start "auto" signal from the power controls, the program unit reads the code punched into the first card. The stepping switch then moves to the azimuth and elevation angle readout positions, setting up the electrical equivalent of the azimuth and elevation angles called for by the card and the structure moves into position. Upon arrival of the structure at this point ,the two position potentiometers indicate "null" agreement with the analog decoding networks and the program unit instructs the card punch to punch into the output card the light and electrical values measured by the indicators. At the completion of this cycle, the next code number in the master deck is read and the cycle repeated until the stop code is reached, at which time "auto" operation is halted and the light receiver and room light circuits are reset. Should trouble develop in the card machine or program unit during test, interlocks will stop "auto" operation within ten seconds.

At the moment, this is a digital, point-by-point positioning system, with the future possibility, however, of taking readings on the fly. It also employs card input and output, although this also could be changed to other methods such as tape if the occasion should demand further speeding up of testing and calculating.

Servo Drives

As mentioned earlier, when the program unit calls for structure movement to a new location, there is a difference in voltage between the structure position potentiometer and the program unit analog decoding network. In either azimuth or elevation this feeds a signal through a motor speed limiting circuit, a current null sensing circuit, and into the control relays. The appropriate drive motor then operates to drive the structure or luminaire to the requested position. When at this position, the null sensor circuit acknowledges agreement and requests the next program step of the card machine.

By means of the manual controls shown to the right of the program unit, the operator may manually position either or both the structure or the luminaire. To aid in this, a synchro-operated, visual shaft position indicator is provided. Under manual control, the operator has the choice of forward-reverse, on-off, full speed range, jog buttons, to whatever angles he selects.

Interesting Design Problems

As mentioned earlier, the laboratory was designed around PAUDGET. Fig. 8 shows the structure at the center with the various indoor and outdoor ranges, control areas, and other laboratory equipment located nearby. Approximately two-thirds of the laboratory floor space is used by the new photometer and its auxiliary equipment. In connection with the outdoor searchlight range, it was necessary to co-ordinate with the building architect to be sure the range was specified on the main building and grounds blueprints. This assures that the range will be considered in any future plans of the department. A track, built into the floor of the laboratory, runs parallel (two feet away) to the centerline of the light beam from the photometer and permits easy placement and location of light receivers with respect to the luminaire under test.

A new innovation in the form of luminaire set-up

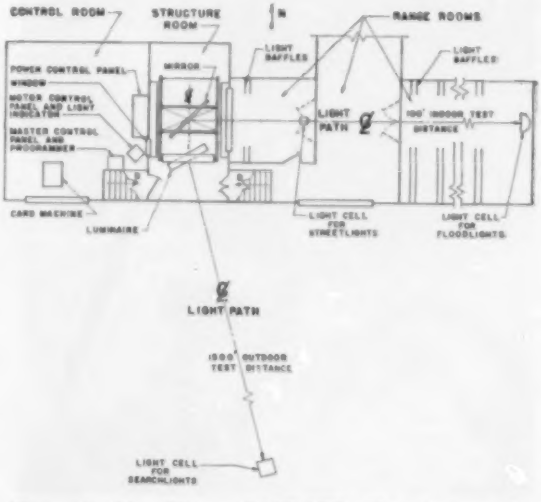

Figure 8. Plan View — PAUDGET. Here is seen the over-all relationship of the control room (left), structure (center), 100-foot indoor range (right), and the outdoor range (foreground).

jigs (see Fig. 9) is being used. These consist of mating plates, so oriented that they can be assembled in only one way. The top plate is common to all wall brackets and photometers, while the luminaires to be tested are mounted on the bottom plates. This permits luminaire setups to be made on the wall brackets and provides minimum photometer set-up time. For example, once a setup has been made on a wall bracket it can be properly mounted and oriented on the photometer in a matter of minutes. Many luminaire setups can be under way simultaneously on the wall bracket mountings. In shifting from luminaire to projector testing it is necessary to convert the photometer structure which is in addition to the normal transfer time.

To minimize thermal drafts and help maintain standard ambient temperature conditions, a large diffusing duct, perforated with thousands of small holes, covers approximately half the ceiling of the room housing the structure. Since operating personnel are in this room only a small percentage of the time, a minimum of air circulation has also been provided.

The structure has been very rigidly constructed to minimize deflection of members due to weight of luminaires, operating personnel, and the large mirror which presented many problems. This is one of the largest mirrors ever made in this country. The mirror is mounted on a honeycomb frame of Honduras mahogany, selected because of its stability. After the seating surface had been made perfectly flat, the mirror was cushioned on a layer of rubber, clamped around the edges, and finally four blocks of wood were glued to the back of the mirror. These provide support for the center area of glass when the mirror is tipped in the downward direction. A delicate balance of design features, components, and pressure in the supports was necessary.

Figure 9. Set-up jigs. View of laboratory technician assembling luminaire with bottom part of jig to the top mating jig welded to the wall bracket. Note the pins that only permit assembly in the approved orientation.

Because luminaires are held in their normal operating position during the test by gravity, and because the structure itself is delicately balanced, it is necessary that the luminaires to be tested and the structure itself be statically balanced prior to running a test. This is accomplished by using properly designed luminaire supports and by the adequate facilities which have been provided on the structure itself. Experimentation is necessary with new luminaires, while data on older or more frequently tested luminaires can easily be referred to in future testing.

The light indicator is the typical rectangular co-ordinate strip chart type of curve plotting recorder, and one might wonder about the earlier requirement of "no curve plotting desired." The initial requirements were for a self-balancing type of indicator, but it was soon discovered that another requirement prohibited its use. To shorten testing time, and still accommodate the rapidly changing light patterns from luminaires, it was necessary to specify an instrumetn having a one-second, full-scale balancing time. This feature is available only on strip chart types of recorders. A current balance type of recorder has been used to eliminate linearity errors when used with photovoltaic cells. Seven ranges, from 0.1 through 100 microamperes provide the sensitivity needed for the wide range of lamps, luminaires, floodlights, and searchlights to be tested. Standard means of attenuating the light can be employed for higher light levels. In addition, the recorder has a built-in electro-mechanical analog to digital converter, permitting direct presentation of the data to the card punch. An automatic current standardizer eliminates instrument error during a test.

A word about the "no curve plotting" requirement. Over the past decade or so much work has been done in photometry in the field of direct curve plotting of luminaire light distributions in one or two cones or planes. It has been time consuming and, many times, of little value. Many more intelligent decisions can be made by an analysis of the major portion or complete luminaire light distribution.

With PAUDGET it is now possible to obtain com-

plete luminaire light distributions in approximately the same time as was formerly required to find and plot only the maximum cone and vertical planes from a luminaire. If only the street side light is needed, it can be obtained in even less time. Why be content with just a cone or vertical plane when, in less time, one can have information on the major portion of the luminaire light pattern for study? If, in design studies, it is desired to observe, on test, light patterns in various paths it will be altogether possible, with the aid of a long persistent screen cathode ray oscilloscope, to observe and photograph these light patterns.

Planning the installation and interlocking of the various electrical and mechanical functions for proper operation began long before the construction of the laboratory. For example, with an automated photometer, room lights in the various rooms must be under the control of the program unit when the photometer is on automatic operation. Cell circuits at various points along the length of the indoor range must terminate in the main control area. Room door interlock circuits and flashing red warning lights were installed around the laboratory to prevent interruptions during automatic operation.

Summary

For the past half century photometric testing and the calculation of test data into usable application data has been a manual, hand operation process. The inability of this method, many times in the past, to make sufficient, accurate information available at the proper time has been a serious inconvenience.

PAUDGET records test data in approximately one-third the time formerly required with the hand operated photometers now in use, and future data processing improvements will permit elimination of about 40 per cent of this time. Today the possibilities are available for producing sufficient and adequate test data; of optimizing luminaire designs more rapidly and of conducting more frequent quality audits of our finished products. For calculations, the time saving at present is about 75 per cent over hand calculation methods, simply by using the accounting type of data processing machines. Once the data are available in card form the type of calculating equipment available determines the calculating and plotting time required.[5] Time previously devoted to routine testing and calculating can be spent doing the creative types of work so necessary to a labortory operation.

The versatility of automation as evidenced by PAUDGET opens the door for greater future progress in the following lines of activity: visibility and comfort studies, brightness studies, testing procedures and accuracy studies, and customer applications.[6] People working in cheerful room environments with fast data accumulating equipment can contribute more fully to the advancement of the art and science of illuminating engineering.

Acknowledgment

The author wishes to express warm appreciation to his wife, Dorothy, and his family, for the patient understanding displayed toward him during the past year. The support, encouragement, and understanding of Mr. C. J. Meloun and Mr. H. J. Flaherty is deeply appreciated. To Mr. P. M. Garratt for the electrical design of the servo and readout circuits. The excellent cooperation of Mr. J. Todt, Mr. W. H. Falls, Mr. D. Strickland, Miss R. G. Hallows, and Mr. H. A. Hamrick over the past few years is recognized with "thanks for jobs well done." Lastly, to Mr. John E. Bock for encouragement and inspiration over the years.

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DISCUSSION

JOHN E. BOCK:* "Operation PAUDGET" represents more than 50 years of progress in the art and science of photometry. This new development is a far cry from those early days of visual photometry. It has been my privilege to see this photometer in operation and I feel that the author has done an outstanding job, not only from the technical aspect, but from a descriptive standpoint as well. There are usually points in a paper of this kind that could, to many of us, be given in more detail, but I realize that their nature may be such that they would be of interest to a comparative few who are familiar with the workings and behavior of photometers. This can undoubtedly be best handled by questions later, when the operation has settled down to routine testing.

It would seem that in this day and age another use for

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photometers would be equally important with the taking of photometric data, and the author has pointed this out. I believe that these new fields, the exploration of glare and its relation to visibility, and the comfort of seeing with outdoor illuminants are so important and necessary that I hope this phase will be explored fully and made available in a subsequent paper.

Another advantage of this photometer will be its use in quality control of the luminaire light performance through the production line. Prior to this development, it was practically prohibitive, because of the time involved, to make such tests.

Having been associated with photometry for many years, it is a pleasure to pay tribute to the author for his ingenuity of approach to the problem and his resourcefulness in overcoming the obstacles which I know are bound to show up in such a radically new approach in ideas and design. May I also pay tribute to his superiors who had the faith to go along with him and also to his company.

G. A. HORTON:* This paper illustrates what can be accomplished when there is an opportunity to design a completely new photometric laboratory. For instance, adequate ceiling height can be provided for designing a goniometer to accommodate today's luminaires, which are sensitive to positional effects, to test them in normal operating position. We, on the other hand, have had only a 12-foot ceiling height available, and have had to solve the problem of testing luminaires in operating position, up to and including 8 feet in length, by a somewhat different method. It is expected that this will be the subject of a forthcoming paper.

Mr. Franklin states that the accuracy of angular measurements is ± 0.5 degree. I do not believe that this would be adequate for searchlights in which the beam width may be only one or two degrees, but trust that this is solved due to the fact that these tests are run manually.

It is also stated that curve plotting is not required or provided for. We, on the other hand, during the course of a luminaire development, find that the automatic plotting of distribution curves in polar or rectangular coordinates is the first requirement of our design people. We provide for this to be done either separately or concurrently with the prescribed photometric exploration when using our automated photometer.[1]

The current balance circuit cannot completely eliminate linearity errors,[2] as the current in the external photocell circuit is never strictly proportional to the illumination, due to back leakage in the cell. The nearest approach is, however, obtained when the current balance or zero resistance circuit is used, and this is generally satisfactory for practical purposes.

We have been automatically plotting isofootcandle curves for quite some time on our Type 704 IBM computer and find this an economical procedure. We also investigated the possibility of plotting isocandle curves on the computer but found this to be uneconomical if the sinusoidal web is used.

It is stated in the paper that projectors of up to 36 inches in diameter may be accommodated. However, it is noted that searchlights up to 60 inches in diameter were developed and produced during World War II.

In examining Fig. 2 of the paper, it is noted that the structural member which supports the luminaire is quite large in cross-section and it appears that this member would block considerable upward light in case indoor types of luminaires with large upward components, such as we have to deal with, are to be tested. At this point, I should like to inquire if any trouble is encountered by possible rocking of the counterweighted yoke when vertical motion of the goniometer is suddenly stopped?

I should also like to inquire if the two large hoops are friction driven by the small drive wheels or if some positive form of drive is provided for?

Light patterns have been viewed for many years by means of the cathode ray oscilloscope,[3] and I should like to ask how this method compares for accuracy with curve plotting by means of a current balance recorder?

Due to the volume of work we are required to handle, we have found it necessary to maintain three separate photometers, one for conventional street luminaires, one for indoor and outdoor fluorescent luminaires and a projection photometry range. Often, it is necessary to operate all of these concurrently.

In conclusion, I should like to congratulate Mr. Franklin on his very interesting and informative paper. He was most fortunate to have had the opportunity to design a new laboratory from the beginning.

References

1. Horton, G. A., Speck, R. C., Zaphyr P. A., and Wendt, B. E.: "Automatic Photometer for Street Lighting and Other Luminaires," a paper presented at the National Technical Conference of the Illuminating Engineering Society, August 17-22, 1958, Toronto, Ont.
2. Preston, J. S.: "Photoelectric Photometers: Their Properties, Use and Maintenance," *Transactions of the IES* (London), Vol. VIII, No. 7, p. 135 (July 1943).
3. Taylor, V. J., and Brown, R. H.: "Lamp Polar Curves on the Cathode Ray Oscillograph," *J. Sci. Inst.*, Vol. XII, p. 253 (August 1935).

E. H. SALTER:* Mr. Franklin and his collaborators are to be congratulated on the job that they have done in designing and constructing PAUDGET. It surely is interesting to see what can be done when a laboratory space and a test equipment can be designed and constructed as a unit. No mention is made of the total cost of such a laboratory arrangement but it would be enlightening to have a round figure of the dollars involved. Information of this nature would determine what other laboratories might expect to do in approaching such facilities.

PAUDGET permits the testing of luminaires in their normal operating position, which we are told is a necessary condition for the proper evaluation of luminaires provided with lamps of certain types. Luminaires using other lamp types have for many years been oriented into other positions for candlepower distribution testing by most laboratories, though in every case finally referenced to normal operating position in the calibration of the photometer. So far there has been no indication that the amount of testing requiring normal positioning of the fixture at all times would in itself justify the expense of the special photometric arrangements to accomplish this end.

There is no indication in the paper as to how the photometer is calibrated, especially for lighting equipment employing fluorescent lamps. Are the "lamp alone" measurements made on PAUDGET or are these values established and tied to a particular beam direction from the complete unit by measurements at some other location?

One of the basic requirements for PAUDGET was "There should be no requirements or provision for curve plotting." The use of the curve drawing recorder in photometry has been one step in cutting down on the man-time requirements

*Westinghouse Electric Corp., Cleveland, Ohio.

*Electrical Testing Laboratories, New York, N. Y.

for testing. A motor driven goniometer enabling the running of curves of candlepower in cones or planes made it possible to dispense with the services of one technician, reduced the required testing time, and gave continuous curves rather than point by point data. All of this has been in the direction of economy of operation. PAUDGET apparently will make some further man-time economy though it is a question as to just how much; comparison in the paper is to completely manual operation. The major saving in man-time is accomplished in computation. Comments on this phase are included in discussion of the Horton, Speck, Zaphyr and Wendt paper.

THOMAS H. LEISTER:* The basic requirements outlined in the paper for PAUDGET seem to have been adequately fulfilled. A photometer of this size, at first appearance, might seem to be more than is required, but when the size and weight of the present day outdoor fluorescent luminaires are considered, it is understandable why a smaller piece of equipment would not do the job.

The ideal automatic recording photometer, in my opinion, would record information enough for a very complete isocandle curve. Then, by means of computers, the data could be processed so as to give any desired curve or set of curves for evaluation such as isocandle, isofootcandle on horizontal or vertical surface, light distribution patterns along longitudinal and/or transverse roadway lines, etc. It would also be required of the computers to give the above information for any tilt of luminaire. Fluorescent luminaires with certain lamps might require testing in the desired tilted position, although a factor might be sufficient.

The paper mentions that, "Extremely versatile programming is possible, and can be changed simply by putting a different deck of master cards in the card punch machine." I assume that this master deck "tells" the photometer the position to take so that a relative apparent candlepower reading may be taken at each position in the desired path or paths dictated by the master deck. Do you then, when a street lighting luminaire is to be tested, record data on cards so that with a single calibration and set-up, enough data is taken so that any method of evaluation can be made on the luminaire?

Under "Servo Drive Circuits," it is said that there are three separate electrical drive systems, two of them for structure elevation motions. Could the author explain what these three motions are? Also mentioned under "Visual Shaft Position Indicator" is the need to know the position of three shafts operating in space. What angular positions of luminaire are obtained about these three shafts?

Is there, built into the luminaire mounting frame, a means for rotating the lamp when it is mounted vertically, base up, in a street lighting luminaire? Does the luminaire have any tendency to oscillate about the pivot points of the horizontal mounting axis?

I would like very much to have an explanation of the development of an isofootcandle chart and utilization efficiency curve. How is the calibration obtained? Are the readings on the opposite sides of the axis of symmetry averaged? What computations are made by the computers? What work is required of the technician to arrive at an isofootcandle chart? Also the utilization efficiency curves? How much time is required to obtain the isofootcandle chart and the utilization efficiency curves?

This is a definite step forward in the testing of outdoor fluorescent luminaires. This photometer is a time saving device for obtaining data, but I am curious as to how much time can be saved with the present method of calculation.

J. STUART FRANKLIN:* The author wishes to thank the discussers for their questions, suggestions and kind remarks. As Mr. Bock has pointed out, there is much that can now be done beyond just taking routine data on luminaires. It is hoped that in the years ahead, it will be possible to conduct investigations into these new fields of lighting research and that such investigations will be the themes of future papers.

In answer to the specific questions asked, I submit the following answers.

The luminaire support yoke subtends a total angle of approximately 16 degrees from a point source located at the junction of the vertical and horizontal centerlines of the structure. This has no effect on either floodlight testing or modern street lighting luminaires.

As to possible rocking of the counterweighted yoke due to sudden stops, we can say that this effect is negligible as the elevation servo drive system brings the structure to a firm but gradual stop. Also, the structure does not move at high speed, but is limited to a maximum speed of one rpm when on either manual or automatic operation.

The two large 8½-foot rings are friction driven by two of the small drive wheels. Structure positioning control is taken from the center of one of the 8½-foot rings and is thus independent of the drive mechanism.

As of this writing we have not employed the use of a cathode ray oscilloscope for viewing light patterns.

PAUDGET is being amortized at a depreciation rate of approximately $5000 per year.

Photometer calibration is made by using incandescent candlepower standard lamps. To date, lamp calibrations have been made in a sphere; however, we hope soon to start bare lamp distribution measurements on PAUDGET so that true relative photometry can be employed.

Our time saving comparisons were made on the basis of hand transcribing of data (either writing or key punching) because that is the way we have always conducted our tests. We never recorded all data in curve form and then transcribed it to the written page. We found it to be longer and less straight-forward to read and verify data taken from recorder curves than to simply write or key punch the data in the first place.

It is possible to so program PAUDGET that sufficient data is taken so that any method of evaluation can be made on the luminaire being tested.

The three separate electrical drive systems provided are as follows:

Street lights — Type "A" goniometer
1. Azimuth rotation of luminaire
2. Elevation rotation of structure

Floodlights — Type "B" goniometer
Azimuth rotation of floodlight yoke (see Fig. 4) — same as for luminaires
3. Elevation rotation of floodlight.

There is no means provided for rotating a lamp, mounted vertically while operating in a street lighting luminaire.

For the development of the utilization curve, I refer Mr. Leister to an article entitled "Iso-Candles" by Frank Benford.[3] The example given in this paper is for a utilization ratio of 2.5; however, the same procedure can be used for other ratios such as 0.5, 1.0, 1.5, 2.0, etc. The "effective

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*Author.

factors" shown in Table XIX would be different for each utilization ratio, but once computed, they can be used over and over. The lumen summation is then made as shown in Table XX. Once the total lumens are known for a given ratio, the utilization of the luminaire in per cent, in terms of bare lamp lumens, can be made by means of a simple ratio of effective lumens at that ratio to rated bare lamp lumens times 100 per cent.

In routine distribution photometry of a luminaire, candlepower readings are taken at the center of each 10- x 10-degree zone of azimuth and elevation angles. Using the candlepower to lumen conversion factors shown in Table XVIII, this test data is converted into zonal lumens. The "effective factors" of Table XIX then convert this zonal lumens value into "effective lumens" for the utilization ratio being considered.

As can be seen in this method, all calculations are made directly on test data, with no intermediate curve plotting or interpretation required.

All necessary calculations are made by machine, the utilization curve then plotted by hand.

Data for the development of the isofootcandle curve is derived directly from test data. Light output is read on the photometer at all required vertical angles in each vertical plane. These are then converted by machine to candlepower and then, for a particular mounting height, into horizontal footcandles. Hand plotting consists of two stages: first, the plots of horizontal footcandles vs. vertical angles, second, the isofootcandle plot.

Depending on the type of distribution from the luminaire, readings are averaged about the axis of symmetry.

From the machine calculated data, it takes approximately one day for a technician to plot the following curves: utilization curve, isocandle diagram, isofootcandle diagram and maximum cone and vertical plane.

1. Benford, Frank: "Iso-Candles," *Transactions of the Illuminating Engineering Society*, Vol. XXI, No. 2, pp. 129-168 (Feb. 1926).

Efficiency of Domed Acrylic Skylights

(Discussion and rebuttal of paper by Edward Linforth, published October ILLUMINATING ENGINEERING)

PHILIP F. O'BRIEN:* An experimental study of the efficiency or effective transmittance of lightwells with acrylic domes is reported in this excellent paper. Because the photometric properties of the skylight system are clearly identified by the author, it is possible to formulate an analytical representation of luminous flux transfer through the lightwell. Analysis of the analogue network which represents this system produces the following expression for the effective transmittance factor of the skylight fixture:

$$\tau_{EF.} = \frac{C_2 C_3}{C_1 + C_2 + C_3} \qquad (1)$$

where:

$$C_1 = \frac{(1-\rho_1)(1-F^2)}{(\rho_2/4k\tau)(1-F^2) + F^2(1-\rho_1)} \qquad (2)$$

$$C_2 = \frac{(1-\rho_2)(1+F)}{1+\rho_1 F} \qquad (3)$$

where:

$$C_3 = \frac{(1-\rho_3)(1+F)}{1+\rho_3 F} \qquad (4)$$

where:

ρ_1 = reflectance of well walls.

$\rho_3 = (1-\tau_0)$ = effective reflectance of acrylic dome as viewed from below; τ_0 is the effective transmittance of the dome without a diffuser as reported in Table II at a well index of zero.

*University of California, Los Angeles, Calif.

TABLE A — Comparison of Measured and Calculated Overcast Sky Transmittance Factors for Acrylic Skylight Luminaires.

		SKYLIGHT DOME TYPE											
		W-7328 DIFFUSER TYPE						W-2067 DIFFUSER TYPE					
Well		None		W-2447		W-7328		None		W-2447		W-7328	
Index	ρ	Measured	Computed	Measured	Computed	Measured	Computed	Measured	Computed	Measured	Computed	Measured	Computed
0.0	—	.35	—	.280	.274	.198	.205	.691	—	.466	.449	.320	.288
0.5	.80	—	—	—	—	—	—	.468	.448	.316	.291	.215	.188
1.0	.80	.163	.176	.117	.118	.087	.077	—	—	—	—	—	—
1.0	.50	.104	.089	.067	.042	—	—	—	—	—	—	—	—

ρ_s = reflectance of the flat ceiling diffuser equal to one minus the transmittance values reported on the first page of the paper; if no ceiling diffuser is used $\rho_s = 0$.

F = shape modulus equal to the fraction of diffuse flux streaming from the well top which is initially intercepted by the well bottom; if Well Index equals zero, $F = 1.0$; Index = 0.5, $F = 0.415$; Index = 1.0, $F = 0.20$.

kr = lightwell index; height/width of square.

The parameters C_1, C_2, and C_3 of Equation 1 are conductances related to the net flux which is lost from the lightwell at the walls, ceiling and floor, respectively. Note that Equation 1 is simply the expression that allows conversion of a mesh network to a tree network.

A comparison of measured and computed values of the effective transmittance of the skylight fixtures is reported in Table A. These data suggest that the effective transmittance can be computed within about 10 per cent error and also point to the excellent internal consistency of the experimental data. Additional calculations for well wall reflectances above eighty per cent should reveal dramatic increases in the effective transmittance.

B. H. Evans:* Mr. Linforth is to be commended for his efforts in skylight research and the resulting paper. This paper is very timely because of the ready market that plastic dome skylights have found in the past few years. Architects, engineers and skylight salesmen, as groups, have been woefully ignorant of the proper use of skylights partly because, until recently, adequate data have not been available. Research performed at Texas A. & M. College in September 1957 showed results very similar to those reported by Mr. Linforth.

This paper is simple, and therefore very good; however, I question the indication that W series acrylic materials are far superior to other acrylics in terms of ratio of light to heat transmission. Other reports on this research from the author's company indicate only slight differences which may even be in the mechanics of measurement. For practical purposes, light is heat, and therefore it would seem that figures for heat gain calculations would be suitable for all acrylic domes if they are suitable for one.

Fig. 1 indicates an infinite amount of light transmission at zero degrees sun angle. This is impossible. The fault lies in the definition of "available light" as light intensity on the horizontal plane only. Transmission should be calculated on a base reading of the sum of sun intensity perpendicular to the sun plus the intensity of the total sky, thus indicating less transmission with low sun angles and zero transmission at zero sun angle.

F. W. Mowrey:** In his presentation, Mr. Linforth indicated somewhat the basis for the index listed in Table II. However, in the paper, it was not particularly clear as to the basis on which the index under "Well Characteristics" was calculated. The data of Table II would be a little more informative if the paper indicated the well geometry on which the index is based.

How do the efficiencies shown in Table II compare to efficiencies of equivalent transmitting flat materials used in sky-lighting?

*Texas Engineering Experiment Station, Texas A. & M. College, College Station, Texas.
**American-Saint Gobain Corp., Pittsburgh, Pa.

Roy C. Kendall:* I wish to compliment the author and his supporting laboratory for providing some useful information on the brightness, transmittance and efficiency of plastic dome skylights. A few questions come to mind, however, regarding the materials tested and the method employed.

Were there any differences in the three types of plastics tested besides apparent density? Were there any metallic elements added to them? What was the well index for the tests reported in Fig. 2 and Table I? Did these tests include ceiling domes below the sky domes?

The tests for total solar energy transmittance which are mentioned in this report should provide architects and engineers with some very much needed information on this subject. It is hoped that the author will publish this data in the near future.

W. S. Fisher:** I am sure the members of our society and others are grateful to Mr. Linforth for making available these data on the brightness and transmission of domed acrylic skylights.

We have become used to having helpful data provided by Mr. Linforth and his associates concerning the application of acrylic plastics to various forms of lighting — luminous ceilings, luminaires, signs, etc. For such applications, the acrylic plastics are eminently suited and are giving a good account of themselves in present-day lighting practice.

However, one cannot help but wonder about the application of skylights to commercial and industrial lighting, since they do not appear to provide illumination efficiently or comfortably, nor, in our experience, do they provide it dependably and economically.

For example, Table I shows brightness data for domes of the W-7328 material which are ten times as bright as that for typical fluorescent luminaires. Even when flat diffusing sheets are added below the skylights, the brightnesses would still appear to be five times as great. Through various approaches, we have succeeded in developing brightness data to the point where limiting brightnesses are specified for luminaires applied in areas where critical visual tasks are performed. Should these brightness data not also be applied to daylighting techniques?

If we assume the skylights tested to be 1½ feet square (though size was not stated, this was the opening of the integrating sphere used in the measurements) and assume further that 8800 footcandles of daylight are available, then approximately 20,000 lumens are delivered to the top of the dome ($8800 \times 2.25 = 19{,}800$). Using a transmission factor rounded off to 0.2 for a dome and diffuser of the W-7328 material, we obtain about 4000 lumens delivered to the room. This is approximately the output of one and one-half 40-watt fluorescent lamps. How many domes would be required to provide 70 footcandles in a classroom? We wonder if the domes can compete in initial installation costs to the $15 to $20 per lamp of typical fluorescent systems.

Furthermore, with the extreme variability obtained in daylighting conditions, illumination at the top of the dome can vary from 10,000 footcandles in sunlight to 100 footcandles under heavily overcast skies. Providing required levels of illumination in interiors would be most difficult under these conditions. We believe that properly planned electric lighting systems can do it better and for less cost.

*Kimble Division, Owens-Illinois Glass Co., Vineland, N. J.
**General Electric Co., Nela Park, Cleveland, Ohio.

TABLE B — Differences between Measured and Calculated Overcast Sky Transmittance Factors, Expressed as Percentages of Measured Factors, for Nominal and Corrected Diffuser Transmittances (τ_d).

		SKYLIGHT DOME TYPE									
		W-2067 DIFFUSER TYPE					W-7328 DIFFUSER TYPE				
Well		None	W-2447		W-7328		None	W-2447		W-7328	
Index	ρ_f	$\tau_d = 1.0$	$\tau_d = .560$	$\tau_d = .606$	$\tau_d = .330$	$\tau_d = .395$	$\tau_d = 1.0$	$\tau_d = .560$	$\tau_d = .606$	$\tau_d = .330$	$\tau_d = .395$
0.0	—	——	2.14−	1.45+	3.50+	15.0+	——	3.62−	2.56+	10.0−	6.85+
0.5	.80	4.3+	——	——	——	8.95+	4.28−	7.83−	2.31−	14.4−	0.70+
1.0	.80	8.0+	0.85+	6.00+	11.5−	2.88+	——	——	——	——	——
1.0	.50	14.4−	32.5−	16.5−	——	——	——	——	——	——	——

EDWARD LINFORTH:* We thank the discussors of this paper for their interest and for the opportunity afforded by their comments and questions to provide additional details. We owe Mr. O'Brien and other readers an apology for not hanging a red light on the nominal transmittance values by which the several materials are identified in the paper. These values are less than the effective values measured with a Baumgartner photometer, with the large integrating sphere under overcast sky, and by laboratory procedures designed to minimize the error inherent in the mensurement of the transmittance of diffusing materials in the Hardy type spectrophotometer. This error arises from the smallness of the sphere aperture in relation to the thickness of the specimen, resulting in the loss of light by diffusion within the specimen beyond the limits of the opening. The loss increases with the thickness and degree of diffusion and becomes significant for materials such as those with which we are concerned here.

By way of atonement, we have calculated the efficiency factors for the same combinations as did Mr. O'Brien in Table A of his discussion, using what we believe are more realistic values for the computation of C_a based on diffuser transmittance measured with the large integrating sphere with the 18-inch opening and no well. These values are: W-7328, .395; W-2447, .606. The results along with Mr. O'Brien's values from Table A expressed as percentages of measured values appear in Table B. The mean difference of the corrected values is 6.75 per cent as opposed to 9.1 per cent for the values based on nominal transmittances.

We are at a loss to understand Mr. Evans' objection to the use of illumination on the horizontal plane as a base for determining skyligh ttransmittance in relation to solar elevation. To have done otherwise would have complicated the gathering of data and, in our opinion, made them no more useful. We agree, however ,that the curves in Fig. 1 appear to be headed for infinity and may be misleading in this respect. They never get there, of course, but change direction abruptly, returning to appropriate values of clear sky transmittance at 0 degrees elevation. The curves were not so drawn because of the magnitude of experimental error encountered at near-grazing angles of incidence.

The well indices in Table II of the paper were calculated by means of the formula, $k_w = k_r = h(1 + w)/2lw$, which becomes h/w for square wells (K. Hisano via Moon and Spencer, *Lighting Design*, page 167). The wells were 18 inches square. Hence, an index of 0.5 indicates a depth of 9 inches and so forth. The brightness and distribution measurements were made with essentially no well ($k_w = 0.05$). What there was of it was painted black so there was no significant component therefrom. No ceiling diffusers were used in these tests.

We have no data on which to base a comparison of the efficiencies of domed and flat skylights of equal transmittance in conjunction with wells and diffusers which Mr. Mowrey requests. If the two are also equivalent in reflectance and distribution, it would seem reasonable to assume no significant difference, as does Mr. O'Brien in his computation of efficiencies.

Two of the three acrylic sheet materials with which the paper is concerned, W-2067 and W-2447, differ only in density. The third, W-7238, differs not only in density but also in the nature of the diffusing agent. The W-2 materials contain minute, discrete globules of a second transparent polymer of slightly higher index of refraction which results in diffusion of light by refraction and internal reflection at each inter-face. These materials theoretically absorb no energy in the visible region, either reflecting it or transmitting it. W-7 materials contain an opaque white pigment with a reflectance in the order of 96 to 98 per cent.

Domes containing "metallic elements" about which Mr. Kendall inquires were included in the evaluation program. Concurrent solar calorimetric measurements of the three dome types revealed no difference between the W-2 and W-7 domes. The data indicated a ratio of visible to total solar energy of 106 lumens per watt for both, as opposed to 97 lumens per watt for the dome containing metallic elements. We agree with Mr. Evans that this is not a large difference, nor did we intend to so imply, but there is no reason to believe that it is not a real one in view of the fact that it is consistent with the absorption factors: 10 to 15 per cent for the metallic fabric, 2 to 4 per cent for the white pigment and almost zero per cent for the W-2 materials.

We can most easily and briefly reply to Mr. Fisher's comments, which invite discussion well beyond the limits of the paper, by considering the skylighting of a room 30 feet square and 10 feet high, with wall, ceiling and floor reflectances of 0.50, 0.80 and 0.30 respectively. In such a room in Ann Arbor, Mich., which we choose because daylight availability data are at hand (thanks to Dr. R. A. Boyd), four skylight fixtures 5 feet square consisting of W-7328 domes and W-2447 ceiling diffusers would provide an average illumination of 30 footcandles, or more, 75 per cent of the time between 8 am and 5 pm throughout the year. Fifty per cent of the time it would be more than 50 footcandles and the occasional maximum would be about 180 footcandles. The ratio of source to task brightness ($\rho_f = .70$) at all times would be approximately 14 to 1.

*AUTHOR: At the time this paper was presented, Mr. Linforth was with Rohm and Haas Co., Philadelphia; he is now a plastics consultant in Hulmeville, Pa.

Among the numerous duties specified for the General Secretary in the Constitution is the requirement that he prepare annually a report for publication in the designated official publication, ILLUMINATING ENGINEERING. This report, based on material recorded from the Officers, Committees, and Sections and Chapters, has been assembled with the assistance of the staff at headquarters. A preview of certain phases of this report was presented at the opening session of the National Technical Conference in Toronto, on August 18, 1958.

The General Secretary Reports

By RICHARD G. SLAUER

Membership

Statistics—Table I of this report shows the present membership of the Society compared with figures at the conclusion of each of the past five fiscal years. These figures continue to show a growth in the major membership classifications. The growth of the Society's membership since 1906 is shown graphically in the curves of Fig. 1.

Table II of this report records the gains and losses for the year and the general accounting of changes in all grades of membership. The over-all net increase of 257 brings the total membership of the Society to 8983. The net increase figure reported here differs from the net gain of 360 reported in the membership campaign. This difference results from the fact that the campaign does not take into account membership losses resulting from death or changes in the Students' membership.

Table III records the Society membership by Sections and Chapters divided according to grade of membership.

Members Emeritus, Fellows—The Constitution of the Society specifies three grades of membership designed to recognize Members who have made contributions to the activities of the Society and to the general field of illuminating engineering. This year action was taken by Council transferring to Emeritus status five Members and Fellows who performed for the Society services of such meritorious character as Council deemed worthy of this honorable reward. They are:

Earl A. Anderson, Michigan Section
C. J. Berry, Maryland Section
R. N. Falge, Indiana Section
Frank G. Horton, Michigan Section
James M. Ketch, Cleveland Section

Based on their valuable contributions to the technical activities of the Society and to the science or art of illumination, ten Members of the Society were recommended by the Board of Fellows and were approved by Council for transfer to Fellow grade.

C. J. Allen
S. W. Bruun
J. M. Chorlton
J. L. Cox
H. F. Davidson
H. U. Hjermstad
R. N. Thayer
H. F. Wall
John S. Walsh
R. L. Zahour

Deceased—The Society records with sorrow the death of one Honorary Member, two Members Emeritus, one Fellow Emeritus, one Fellow, 22 Members and 34 Associate Members during the fiscal year.

Honorary Member
Langmuir, Irving

Members Emeritus
Burton, Robert B., Sr. Whitney, Willis R.

Fellow Emeritus
Hawkins, Laurence A.

Fellow
Clarke, Albert Howe

Members

Ashley, Edward E.
Bos, John
Chaffer, John R.
Chauvin, Wilbrod A.
Dickson, Thomas
Elliot, Clifford I.
Gibbs, Clayton T.
Goetz, Louis W.
Gresham, W. E.
Haverkamp, John D.
Jacob, J. G.
Johnson, Charles Wilce
McPhail, Robert G.
Nelson, Walter F.
Owens, Paul T.
Patterson, George W.
Phillips, J. L.
Prag, Elmer R.
Smiley, A. E.
Wagner, Walter Calvin
Whalen, Thomas J.

TABLE I — Membership as of September 30.

	1953	1954	1955	1956	1957	1958
Members and Fellows Emeritus	32	34	35	37	40	41
Fellows	70	78	89	99	106	113
Members	1,870	1,939	1,979	2,123	2,212	2,410
Associate Members	5,579	5,621	5,887	6,036	6,211	6,304
Student Members	244	230	188	185	157	116
Total	7,795	7,902	8,178	8,480	8,726	8,983

TABLE II — Gains and Losses in Membership During Year Ending September 30, 1958.

	Members/ Fellows Emeritus	Fellows	Members	Associate Members	Student Members	Total
October 1, 1957	40	106	2,212	6,211	157	8,726
Gains						
Elections			167	1,002	54	1,223
Reinstatements			29	86		115
Transfers	5	10	160	9	1	185
Total Gains	5	10	356	1,097	55	1,523
Losses						
Resignations			70	374	88	532
Dropped			53	435		488
Deceased	4	1	21	34		60
Transfers		2	14	161	8	185
Total Losses	4	3	158	1,004	96	1,265
Net Change	1	7	198	93	−41	258
Total Membership as of September 30, 1958	41	113	2,410	6,304	116	8,984

A Transaction of the Illuminating Engineering Society.

TABLE III — Membership of Sections and Chapters as of September 30, 1958.

	Associate Members	Members	Students	Fellows	Members Emeritus	Fellows Emeritus	Total
CANADIAN REGION							
Bluenose Chapter	25	13					38
Forest City (London) Chapter	16	5					21
Hamilton, Ontario Chapter	25	9					34
Maritime Chapter	34	8					42
Montreal Section	83	36					119
Ottawa Section	42	11					53
Quebec Chapter	18	5					23
St. Maurice Valley Chapter	17	6					23
Toronto Section	142	53	1	6	1		202
Winnipeg Chapter	46	9					55
EAST CENTRAL REGION							
Capital Section	69	44		7			120
Eastern Pennsylvania Section	129	41	1		1		172
Maryland Section	57	22			1		80
Philadelphia Section	199	87		4		1	291
Pittsburgh Section	133	76	3	1			213
Virginia Section	35	23			1		59
GREAT LAKES							
Central New York Section	92	35	1	2			130
Cleveland Section	219	121		28	4	3	375
Miami Valley Section	57	15	3	1			76
Michigan Section	199	78	4	3	3	1	288
Northwestern Ohio Section	45	20					65
Ohio Valley Section	54	28	1				83
Rochester Section	119	21		1			141
Western Michigan Section	54	22					76
Western New York Section	62	11	1				74
INTER-MOUNTAIN							
Arizona Section	76	27	1				104
New Mexico Chapter	32	3	2				37
Rocky Mountain Section	49	19		1			69
Southern Colorado Chapter	18	8		1			27
Utah Section	41	20					61
MIDWESTERN							
Central Illinois Chapter	37	12					49
Chicago Section	323	133	5	6	3	3	473
Cornhusker Section	70	19					89
Heart of America Section	88	34					122
Indiana Section	55	27	2		1		85
Iowa Section	63	24					87
Milwaukee Section	169	38	1	2			210
Ozark Chapter	20	22					42
St. Louis Section	148	38	1	2			189
Twin City Section	165	30					195
Twin Ports Chapter	35	7					42
NORTHEASTERN							
Connecticut Section	114	45		2	2	1	164
Eastern New York Section	54	17		1	1		73
New England Section	238	92	3	7	3		342
New York Section	365	207	5	18	1	1	597
Yankee Chapter	40	14					54
PACIFIC NORTHWEST							
British Columbia Section	58	22					80
Chinook Chapter	21	12					33
Edmonton Chapter	65	13					78
Inland Empire Chapter	40	15	1				56
Oregon Section	62	34	13		1		110
Puget Sound Section	75	28	3	1			107
Vancouver Island Chapter	21	3					24
SOUTH CENTRAL							
Alabama Section	58	24		1			83
Arkansas Chapter	19	4					23
Mid-South Chapter	20	11	20				51
Mississippi Chapter	31	6					37
New Orleans Section	69	23					92
Tennessee Valley Section	42	23					65
SOUTHEASTERN							
Coastal Empire Chapter	15	6					21
Florida Section	80	22	2		1	1	106
Georgia Section	86	62	2				150
Palmetto Section	66	26		1			93
Southeast Florida Section	62	16	22				100
Suwannee River Chapter	24	14	1				39
Tar Heel Section	81	38	1	1			121
SOUTH PACIFIC COAST							
Golden Gate Section	256	63	2	2	1		324
Mother Lode Chapter	24	18		1			43
San Diego Section	40	21			2		63
San Jose Section	21	8		1			30
Southern California Section	243	84	3	5	1	1	337
SOUTHWESTERN							
Alamo Section	42	8	1	2			53
Ark-La-Tex Chapter	42	10					52
Central Oklahoma Chapter	40	5	2				47
Coastal Bend Chapter	12	12					24
North Texas Section	111	33	2	2			148
Oil Capital Section	37	17	1				55
Panhandle Chapter	20	7					27
San Jacinto Section	33	24	1				58
South Plains Chapter	32	7					39
Mexico Chapter	27	4	2				33
Foreign Non-Section	158	52	2	3	2		217
TOTAL	6304	2409	116	113	29	12	8983

TABLE IV — New Chapters Established During 1957-58.

No.	Chartered by Council	Name	Headquarters City	Region
78	December 12, 1957	South Plains	Lubbock, Texas	Southwestern
79	December 12, 1957	Coastal Bend	Corpus Christi, Texas	Southwestern
80	December 12, 1957	Forest City	London, Ontario	Canadian
81	April 30, 1958	Ozark	Springfield, Mo.	Midwestern

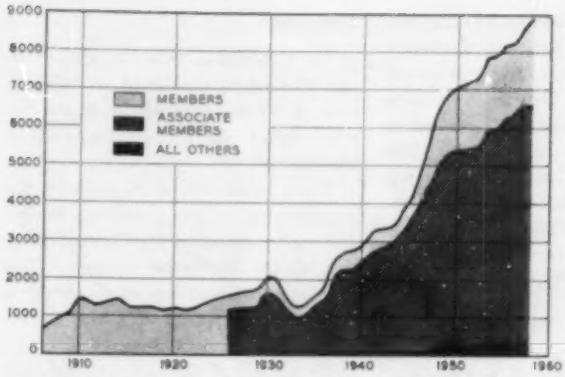


Figure 1. Membership: Total, Members, Associate Members, all others.

Figure 2. Growth of the Society in numbers of Sections and Chapters.

Associate Members

Allen, L. T.	Knudsen, Fred
Anastasi, Joseph J.	Kopp, David B.
Butcher, Howard E.	Levy, Milton L.
Christopher, I.	Meyers, H. F.
Cleary, M. J.	Miner, J. J.
Clunk, H. M.	Moody, Harold S.
Fleming, A. J.	Newman, William A.
Fuerst, G. P.	Niemeyer, James C.
Goodman, C. L.	Pavesich, Peter M.
Gregory, F. S.	Potts, Robert M.
Gross, L. H.	Priest, Lucian Charles
Heyburn, Henry B.	Sprague, C. H.
Howard, Harold Wesley	Stiles, Bert W.
Hunt, Selene	Stone, Thomas C.
Jaeger, H. K.	Stryker, Edward D.
Kaiser, Heins	Thomas, J. Richardson
Kertson, J. A.	Warren, Thomas R.

Regional Activities

The Regional Activities Committee, made up of the eleven Regional Vice-Presidents with J. B. Browder, Vice-President, as Chairman again carried on an active program of assistance to the Sections and Chapters and to the regional operation. Illness somewhat limited the activity of Reuben Lothrop, Vice-President of the Southwestern Region and before the end of the fiscal year caused him to resign his office.* A majority of the Regions scheduled meetings of key Section/Chapter officers and Chairmen in the Fall for organizational planning. All Regions scheduled a similar meeting in connection with their Regional Conference; in the case of the Canadian Region, during the National Technical Conference in Toronto.

The Regional Activities Committee scheduled five full-day meetings, in conjunction with the five Council meetings. Included in the agenda of these meetings was the discussion of reports on a number of study projects undertaken by the Regional Vice-Presidents. Of the 13 projects assigned, six were completed during the year:

*His death, September 19, was recorded in October ILLUMINATING ENGINEERING. — ED.

1 — Regional Representatives and Regional Organization — This report emphasized the soundness of the present policies and structure but urged that greater activity was needed in relation to these policies and structure. In particular, it was urged that an early (June 1 to Oct. 1) Regional Planning Meeting be held.

2 — Local Representatives — This report expressed opinions and recommendations in regard to Local Representatives.

4 — New York State Region — Removed from docket as not pertinent for immediate consideration.

10 — Regional Conference Technical Programs — This report reviewed considerations in establishing the technical program for Regional Conferences and the selection of speakers for these Conferences.

11 — Student Branch Operations — This report summarized several considerations in regard to the operation of Student Branches but emphasized that the Society's Committee on Student Membership had just issued a comprehensive report which suggested no further need for RAC study at this time.

13 — Charter Meeting Procedure — This report included a suggested outline of procedure and agenda items for Charter Meetings and stressed the values derived from good organization and careful planning of meetings.

Section and Chapter Programs — The 82 Sections and Chapters of the Society all carried out programs of service through organization of their local memberships and committees. According to reports received at headquarters, over 700 regular and special meetings were held during the year, mostly on a monthly basis, with an attendance of members and guests of over 30,000. The scheduling of speakers and subjects for these meetings provides the largest opportunity for direct participation by the membership in the Society program.

A number of the local groups operated as a regular part of their local program, a study club or technical forum, offering the more detailed discussion of the technical aspects of illuminating engineering.

Residence Lighting Forums continue to be an important activity of ten of the Society's Sections.

Operating under the revised Guide prepared by the Lighting Service Committee a majority of the Sections and Chapters scheduled "My Most Interesting Lighting Job" Contests. Winners in the local contests, which provided unusually fine local programs, went into the Regional Conference competitions.

New Chapters and Sections — As tabulated in this report, four new Chapters were chartered by Council action during the year. Toward the close of the fiscal year two other local groups, both in California, were in the final stages of completing charter requirements — Yosemite Chapter at Fresno, and Arrowhead Chapter at Riverside. Following lengthy deliberations the membership in the New York Section, largest of the Society's local groups, decided to separate the group in New Jersey, forming the New Jersey Section. Council approval was given to this establishing of the 82nd local unit of the Society, which began

immediately the planning of a comprehensive program of service to its members.

Local Representatives — The Sections and Chapters handled the appointment of local representatives to carry on the work of the Society in areas not served directly by the local programs of Sections and Chapters. These members, in some instances, were organized into active Extension Committees.

Student Branches—During the year, four of the Society's Student Branches continued active and four were inactive. No new Branches were formed during the year. Regular meetings and programs were operated by the Student Branches at the Oregon State College, Southern College of Optometry, University of Illinois, and University of Miami.

Regional Conferences — Excellent Conferences were held in all of the Regions except Canadian, which was host to the 1958 National Technical Conference. Following the practice of recent years the Southeastern and South Central Regions collaborated in the Conference at Little Rock. The record of the 1958 Conferences follows, including the Chairmen of the Conference Executive Committees:

East Central — April 14, 15 — John Marshall Hotel, Richmond. Chairman — J. Shelton Ragland.
Great Lakes — June 23, 24 — Sheraton Hotel, Rochester. Chairman — Norman T. Kridel.
Inter-Mountain — May 8, 9 — Continental Motel, Pueblo. Chairman — E. H. Pemberton.
Midwestern — May 1, 2 — Hotel President, Kansas City. Chairman — B. F. Kindell.
Northeastern — April 10, 11 — Statler Hotel, Hartford. Chairman — Robert H. Chase.
Pacific Northwest — May 22, 23, 24 — Multnomah Hotel, Portland. Chairman — Walter E. Potter.
South Pacific Coast — May 13, 13 — El Cortez Hotel, San Diego, Chairman — J. Walter Howard.
South Central, Southeastern — April 24, 25 — Lafayette Hotel, Little Rock. Chairman — J. S. Williams.
Southwestern — April 28, 29 — Washington Youree Hotel, Shreveport. Chairman — J. G. Harriss, Jr.

Finance

The Committee, with W. P. Lowell, Jr., Chairman, continued its supervision of the financial affairs of the Society under the general direction of the Council.

The Committee's work included the preparation of an operating budget and its presentation for Council adoption at the September meeting. This also involved a review of the requests from all Sections and Chapters for budget allotments for the year.

As a result of the favorable outcome of the fiscal year 1956-1957 and the availability of funds being held in savings accounts, the Committee recommended transfers to reserve, bringing the reserve total to over $150,000. Because of the size of this reserve and the importance of putting the management of these funds on a current basis, the Committee recommended to Council that the reserve be placed in the hands of professional management. Subsequent to Council's approval of this recommendation, the reserve funds were transferred to the Advisory Custodian Service of the Irving Trust Co., New York. The Treasurer and the General Secretary, upon recommendation of the Finance Committee, will continue to have the responsibility for investing Society funds in accordance with the policy approved by Council.

The Committee reviewed and recommended for Council approval the financial reports for the 1957 National Technical Conference and the proposed budget for the 1958 National Technical Conference.

As publication plans for the third edition of the *IES Lighting Handbook* were revised during the year, reconsideration was given to the special Handbook budget originally approved by Council in December 1956. As a result the revised Handbook budget submitted by the Publications Committee was recommended for Council approval at the December meeting.

The Annual Report on the Society's financial condition was presented to Council at the April meeting.

Fiscal Year Statements—The official financial statements for the year are as given in the report of the auditor, MacNichol, Johnson & Company. These include statements of income and expense for the fiscal year, and the balance sheet as of September 30, 1958.

Statement of Income and Expense for the Year Ending September 30, 1958

INCOME

Annual Dues		
Fellows	$ 1,861.00	
Members	40,799.75	
Associate Members	89,339.03	
Student Members	528.75	
Entrance Fees	3,062.50	$135,611.03
Sustaining Members		64,815.02
Sales, Publications, Gross		
IES Lighting Handbook, 2nd Edition	5,351.31	
Lighting Data Sheets	2,398.95	
Reprints	11,969.17	
ILLUMINATING ENGINEERING	13,966.64	
National Technical Conference Preprints (1958)	1,730.39	35,416.46
ILLUMINATING ENGINEERING, Advertising		117,994.70
Sales, Net, Publications, Bulk Journal		2,093.22
Sales, Badges and Certificates, Gross		986.50
Investments		5,405.16
1958 National Technical Conference Income	16,013.15	
Less Expense	10,835.38	5,177.77
Miscellaneous		214.60
TOTAL INCOME		$367,714.46

EXPENSE

General		$ 11,313.11
Office, Business	$ 61,978.92	
Office, Technical	48,586.31*	
Office, Publications	57,771.06*	168,336.29
Organization, General Committees	11,285.14	
Sections and Chapters	32,766.96	
Regional Vice Presidents' Travel	3,000.00	
President's Travel	4,000.00	51,052.10
Sales, Badges and Certificates		817.05
Depreciation, Publications Stock		920.66
ILLUMINATING ENGINEERING to membership		65,291.66
Sales, Publications, Cost of Stock		
IES Lighting Handbook, 2nd Edition	3,390.21	
Lighting Data Sheets	744.77	
Reprints	5,721.03	
ILLUMINATING ENGINEERING	8,280.55	
National Technical Conference Preprints (1958)	1,389.29	19,525.85
Sales, Publications, Stock, Services; Sales and Advertising Promotion		8,920.15
Retirement Pension Plan		6,947.32
Federal Social Security Tax		1,874.58
To I.E.S. Research Fund		20,500.00**
TOTAL EXPENSE		$355,500.77
NET INCOME		12,213.69

*These figures include a total of $20,728.61 which has been deferred to Handbook III Expense.
**An additional contribution of $15,000 was given to IE Research Institute from surplus.

Balance Sheet as of September 30, 1958

ASSETS		
Cash in banks and office		$ 57,302.11
Marketable securities, at cost		124,447.53
Accrued interest receivable		252.16
Accounts receivable		9,308.91
Inventories of publications, badges and certificates, at cost		6,634.90
Furniture and equipment, at nominal value		1.00
Deferred Charges		
Production costs, ILLUMINATING ENGINEERING	$ 7,199.77	
Conference Preprints	1,275.03	
IES Lighting Handbook, 3rd Edition	29,006.25	37,481.05
Other Assets		
Advances to Sections and Chapters	3,456.09	
Travel Advances	2,225.00	5,681.09
TOTAL ASSETS		$241,108.75
LIABILITIES AND SURPLUS		
Liabilities		
Accounts Payable		$ 1,786.52
Deferred Income		
Subscriptions to publications received in advance		5,371.95
Surplus		233,950.28
TOTAL LIABILITIES AND SURPLUS		$241,108.75

Constitution and Procedures

Based on studies by the administration and the respective committees, action was taken by the Council at the start of the fiscal year, to approve the establishment of the Constitution and Procedures Committee combining the functions of the previous two committees — Constitutions and By-laws, and Procedures and Policies. This new combined function is embraced in the stated committee scope: "To prepare proposed amendments to the Constitution and By-laws, to prepare statements of policies and procedures consistent with the Constitution and By-laws and to report to Council."

The principal efforts of the Committee during the year were directed toward completing the sizable task initiated in May 1955, on the revision of the Constitution. The stated objectives were to:

1) Separate basic policy and organization from procedure.

2) Revise statements which are ambiguous or which are contrary to present policy and procedure. (The "vote of Council" is an example.)

In submitting the revised Constitution to Council and subsequently to the whole membership, it was noted that there had been no basic changes in policy or organization. It was also noted that the amended Constitution compared with the present Constitution as follows:

— Some Articles and Sections unchanged.

— Sections of some Articles are carried over into the By-laws (these consisting of procedures).

— Sections in some Articles were edited and re-written.

The revision of the Constitution as approved by the Society membership appears in the July 1958 issue of ILLUMINATING ENGINEERING, pages 411-414 inclusive.

Management

The affairs of the Society are managed by the Council of the Society principally through discussions and decisions reached at the five scheduled meetings.

The Executive Committee of the Council, which is made up of the five national officers, conducts the affairs of the Society between Council meetings.

At each of its five meetings Council received regular reports from the principal Standing and General Committees, as well as progress reports on the Technical Committee program presented by the Technical Director. Several meetings of the Council and Executive Committe considered at length the progress reports of the Committee drafting revisions in the Society's Constitution and By-laws.

During the year, a considerable amount of Council time was devoted to the study of a number of important problems. These included:—

Headquarters Location:— Acting on the recommendation of the Advance Planning Committee, the Council confirmed President Reid's appointment of a Task Committee to "study all factors affecting the choice of future location of Society Headquarters." This Committee, with Past President M. N. Waterman, Chairman, studied the subject at length and in its final report to Council recommended:

(1) That the Society Headquarters remain in New York City unless the Task Committee or its successor, in its continuing study finds more concrete evidence than now at hand to substantiate a move.

(2) That the Committee on Headquarters Location be maintained until such time as deemed unnecessary. This would permit continuing study as to the best location in relation not only to factors currently considered, but also in relation to changing Headquarters organization and possible changes in the number, scheduling and location of Council meetings.

The committee also studied the question as to whether or not the Society should move Headquarters to the United Engineering Center to be erected and operated by the United Engineering Trustees.

Council also accepted the Task Committee's report on this aspect of the subject deciding that the Society is not in a position to consider occupancy on the basis of the terms offered.

Headquarters Organization:— Another recommendation of the Advance Planning Committee, in 1957, involved more study by the Council and officers than any other subject during the fiscal year. The subject developed from the committee's conviction that the present duties of the President are beyond the realm of reasonable proportion; and that the Society organization should be augmented to relieve the President of many operating details.

Because of the vital importance of the matter Council authorized that a study of the committee recommendations be made by a well-known firm of Management Consultants, Cresap, McCormick and Paget. The resulting report was discussed by Council at its June meeting and was accepted in principle, action being taken to appoint a Task Committee to give the survey further study and to recommend a definite step by step program. The report of this Committee, headed by Past President R. F. Hartenstein, was the basis for Council action.

The action of Council included approval of the establishment of another new position at Headquarters, to be known as Membership Secretary-Office Manager; this new staff member will

assume many of the duties previously carried by the Executive Secretary and this position will be eliminated.

At the close of the fiscal year action was taken implementing the recommendations in the several reports with the appointment of a Managing Director, to function in four key areas:

1. More efficient and more effective Headquarters operation.
2. Direct service to the officers and Council for their more effective operation.
3. Long range analysis and planning.
4. More field service in connection with Region-Section-Chapter operation.

First appointment in the new position was A. D. Hinckley who has served as the Society's Executive Secretary since 1944.

IES Lighting Handbook:— At its first meeting Council considered at length the Executive Committee recommendation that the current revision leading to the third edition of the Handbook, include up-to-date tables of recommended illumination levels (to be developed on the basis of Dr. H. R. Blackwell's Research nearing completion at the University of Michigan). Acting on the situation resulting from the delay in publication, studies of the respective aspects of the problem were made by the Handbook Revision Committee, the Publications Committee and the Finance Committee. Reports by these Committees were received by Council during the year, including two revisions of the special Handbook budget.

Illuminating Engineering Research Institute:—At every meeting of Council and its Executive Committee during the year, consideration was given to the financing of the Research Institute Program. This involved the question of a regular assured program of transfer of Society funds to the Trustees as a basis for their prompt commitment for contracts covering new research projects. Also involved was the development of increased financial support for the Research Institute which was rapidly increasing the number and size of basic researches on quality and quantity of illumination. Toward this objective the Council approved during the year, the allocation of some $15,000 from 1956-57 operating surplus, in addition to the $20,500 already assigned in the 1957-58 Society budget.

Toward the close of the fiscal year there was considerable discussion of the 1958-59 Research Institute program, involving pending contracts totalling $75,000. Since funds of this magnitude devoted to basic research did not seem possible through Society channels, the Trustees preferred to initiate a solicitation to Foundations, companies, and some organizations outside of the lighting industry. As the year closed, this was under careful study as to its effect upon the regular support given the Society and research programs through the Society's Sustaining Members.

Technical Committee Reports Approved:— Official action was taken by Council in connection with the following reports of Technical Committees during the year.

Aviation Committee
Lamps for Aircraft Lighting—Recommended Practice.

Institutions Committee
Proposed Recommended Practice for Reporting the Photometric Performance of Incandescent Filament Lighting Units Used in Theatre & Television Production.
Lighting for Hotels.
Illumination Recommendations — Revised Footcandle Tables Based on Blackwell Research.

Light Control and Equipment Design Committee
Recommended Light Characteristics of Polystyrene Used in Illumination.
Guide to Design of Light Control, Part I — Physical Principles, Part II — Design of Reflector and Optical Elements.

Progress Committee
Annual Report.

Public Conveyances Committee — Interior Lighting
Recommended Practice for Marine Lighting.
Illumination Recommendations — Revised Footcandle Tables Based on Blackwell Research.

Nomenclature Committee
Proposed Changes in ASA Z7.1 for Adoption of term Luminous Efficacy.

Testing Procedures Committee for Illumination Characteristics
Proposed Guide for Reporting General Lighting Equipment Engineering Data.

Recommendations for Quality and Quantity of Illumination Committee
Illumination Recommendations — Report #1.

Office Committee
Illumination Recommendations — Revised Footcandle Tables Based on Blackwell Research.

Daylighting Committee
Lighting for Low Ceiling Classrooms.

Industrial Committee
Illumination Recommendations — Revised Footcandle Tables Based on Blackwell Research.

Residence Committee
Illumination Recommendations — Revised Footcandle Tables Based on Blackwell Research.

Store Committee
Illumination Recommendations — Revised Footcandle Tables Based on Blackwell Research.

Illuminating Engineering Research Institute

The Society has continued to follow the program of the Institute this last year. From a list of nominees approved by Council, the Institute's Board of Trustees took action to have the following personnel serve in the administrative and technical operations of the Institute:

Board of Trustees
A. F. Wakefield, *Chairman*
Franklin M. Foote, M.D., *Treasurer*
Conrad Berens, M.D.
O. R. Doerr
Willard E. Hennes
Kirk M. Reid
M. N. Waterman
C. L. Crouch, *Secretary*

Research Executive Committee
E. M. Strong, *Chairman*
H. F. Davidson
G. A. Fry
Leonard C. Mead
Bob H. Reed
R. M. Zabel

According to the Trust Agreement, the Institute's 1957 Annual Report was submitted to Council, as were progress reports during the year by the Secretary, C. L. Crouch. Summarizing these for 1957-58, the following should be noted regarding the specific projects.

#30-B-C-D-E-F—"Further Research on Visual Performance and Quantity of Illumination" — Dr. H. R. Blackwell, University of Michigan — Dr. Blackwell and his associates, over a period of eight years of Institute-sponsored research, have developed a scientific method for specifying the quantity of interior illumination required to perform any practical visual task. These results were reported at a Research Symposium in March 1958 at Dearborn, Mich., to which were invited all chairmen of the Society's technical committees, and also presented in a paper by Dr. Blackwell at the Society's National Technical Conference in August. (From the Blackwell research the Committee on Recommendations of Quantity and Quality has developed a report for use by the application committees in arriving at illumination recommendations.) Work on the quantity research program is continuing.

#47-C — "Visibility in Fog," Dr. H. R. Blackwell, now with Ohio State University—Publicity of the results of this program produced wide public interest and has been responsible for extending the studies through turnpike

contributions to develop and evaluate quantitatively improved lighting for the roadway and the vehicles.

#48 — "Effects of Quality of Illumination and Color of Background on Color Preference," Dr. Harry Helson, University of Texas — This project has been reactivated (delayed due to illness) to see if there are inherent patterns of color preferences for use in interior design.

#49 — "Hot Spots in Luminaires," Dr. Glenn A. Fry, Ohio State University — This study, which involves determining the relative glare effectiveness of "hot spots" in luminaires, is continuing with additional tests to be made with newly developed apparatus.

#51 — "Discomfort Glare at Low Adaptation Levels—Multiple Sources," Prof. R. C. Putnam and Keith D. Bower — Case Institute of Technology — Results of this research (to determine the effect of multiple sources in the field of view under low levels of illumination) were published in the April issue of ILLUMINATING ENGINEERING.

#52 — "Loss of Contrast Due to Specular Reflection," Prof. D. M. Finch, University of California — Professor Finch presented his report on this work at the Research Symposium in March 1958, giving considerable data on losses, including sets of curves for pencil work and printed material covering a series of vertical planes of the light source at varying degrees of azimuth. These data on pencil work have permitted calculation of losses of contrast in rooms having a particular layout of lighting units. As soon as funds are available this work will be extended to give a comprehensive report for practical application.

#58 — "Disability Glare Meter," Dr. Glenn A. Fry, Ohio State University — Work is being done to develop a new disability glare meter. A preliminary report was presented at the March 1958 Research Symposium.

#60 — "Studies of Visual Discomfort by Multi-Dimensional Psychophysical Measurements," Robert A. Hefner, University of Michigan — Work on the psychological analysis of the BCD Method of Luckieth and Guth and the Multiple-Criterion Method of Hopkinson is proceeding to see if the psychological scaling approach supports the subjective evaluation of discomfort glare.

Fourteen new proposals have been submitted to the Institute this year, and ten contracts written. One of these involved Project #59, "Glare from Very Large Sources," being carried on at Cornell University. Dr. Hopkinson presented a progress report on this at the Society's National Technical Conference. This work will cover the discomfort-glare effects from luminous ceilings or portions of ceilings, and large areas of daylighting fenestration.

The Institute has now developed and published a public information booklet describing the Institute and its program, which has been needed for some time. Copies were given to the President of the Society for circulation to Sustaining Members.

Publications

Several special publication projects were undertaken this year by the Publications Committee under Dr. R. M. Zabel, Chairman, and carried out at headquarters by Ruby Redford, Editor, and Clayton E. Ellis, Advertising and Sales Promotion Manager. In addition to the Society's regular publications — the monthly journal ILLUMINATING ENGINEERING, Lighting Data Sheets and Technical Committee Report booklets, the program also included production and business details of the Third Edition *IES Lighting Handbook*, and the development of Data Sheet "packets" consisting of a group of sheets covering specific subjects. Another such group, on decorative lighting techniques for homes, is being planned for production early in 1959, the compilation being developed by the committee's sub-committee on Residential Data Sheets, Eve Freyer, Chairman.

A coordinated program of local participation in the Society's publication work was continued again this year. Under this organizational set-up ten Regional Publications Representatives and two appointments in each Section and Chapter were proposed. The local program for publication sales was under the direction of Brooks Chassaing, Chairman; the editorial procurement and data sheet program under R. W. Morris, Chairman. All of this organization was aimed at further improving the Society's magazine ILLUMINATING ENGINEERING, and for the distribution of the Society's published material.

TABLE V — Page Content of ILLUMINATING ENGINEERING October 1957 — September 1958

	Number of Pages Published
Conference Papers, Abstracts and Discussion	314
Technical Committee Reports	120
General Secretary's Report	16
Other Technical Papers	22
Application Articles	137
Data Sheets	42
Lighting News	136
Editorials	12
Committee Personnel, Officers, Sustaining Members	41
Advertising	465
	1305

As part of its continuing program of reporting good lighting practice throughout the country, ILLUMINATING ENGINEERING this year published a record number of "application articles" on current techniques (see table of page content) in addition to the Society's official Transactions, papers on illumination studies, and news of the industry.

In the Society's advertising and publications sales programs, advertising in ILLUMINATING ENGINEERING has continued to contribute substantially to the Society income and, despite generally depressed conditions throughout the publishing field. has virtually equalled 1956-1957 in number of advertising pages, exceeded last year in income. With but few new publications available, the local sales program through Section and Chapter Publications Sales Representatives has progressed somewhat slowly but these representatives have shown remarkable aptitude and the membership in general has become more and more aware of the uses and value of Society publications.

Marked progress is being made in setting up a broad program for distribution of the Third Edition, *IES Lighting Handbook*, when published in March, 1959. The space contracts and the preparation of material for manufacturers in the Manufacturers' Reference Data section of the new Handbook has proceeded satisfactorily.

Standing Committees

Seven Standing Committees are set up by Constitutional provision and reference has been made earlier in this report to the work of three of these, Council Executive, Finance and Publications. Reports for the remaining four follow:—

Board of Fellows

George E. Shoemaker, Chairman

The Board met in April to consider nominations for transfer to Grade of Fellow. Prior to the meeting each member was provided with information regarding all candidates, so that the members of the Board had opportunity to study the candidates' qualifications before the meeting.

Ten nominations for the Grade of Fellow were approved and recommended to Council for action at its June meeting, along with suggested citations briefly describing the contributions of the nominees.

Papers

H. F. Davidson, Chairman

This committee carried out the assigned duties of soliciting and selecting the technical papers for the National Technical Conference. In addition the Committee served as a technical advisory group to the Publications Committee for review of articles prior to publication.

A tentative selection of 40 Technical papers was made from approximately 70 proposals submitted. Of these 36 received final approval for Conference presentation after the complete papers were reviewed by the committee. In order to handle this number of papers and their discussions in the time available it was necessary to continue the use of parallel sessions.

The "Research" session was of special interest by reason of the timely and important subjects included on the program. Due to the wide interest in this session there was no parallel technical session.

During committee meetings, discussions took place with regard to the revision of the "Guide for Authors" which has been out of print for some time. It is expected that this will be one project on which there will be some action taken by the 1958-1959 committee.

General Board of Examiners

Ralph H. MacVean, Chairman

During 1957-58 the Board held ten meetings at Headquarters for the evaluation of application for election in Member grade or for transfer to Emeritus or Retired status. There was an unusual volume of such applications, resulting in the favorable recommendation to Council in 361 instances.

The Board also reviewed the By-laws, Article II, (a) Section 2 detailing the qualifications meeting the constitutional requirements for Member grade. The Board's resulting recommendations were accepted by the Constitution and Procedures Committee in its 1958 revision of the By laws.

Medal Award

L. E. Tayler, Chairman

In accordance with approved procedure, the first committee meeting was held in Dearborn, Michigan early in January. Subsequent distribution of material to the Committee for study of the qualifications of nominees indicated the need for the second meeting in April. This was held in Cleveland. The committee, by ballot, recommended that Cromwell A. B. Halvorson of Salem, Massachusetts be the recipient of the 1958 Gold Medal. The citation accompanying the nomination to Council described Mr. Halvorson's approach to lighting design which embraced a compelling desire to enhance the safety of our citizens. His solutions accommodated the theoretical with the practical and the aesthetic, thus insuring results acceptable both to the industry and to the public at large.

General and Task Committees

The General Committees of the Society are charged with the operating functions not handled by the Standing Committees, and not pertaining to the preparation of reports on scientific and engineering subjects. The work of the Regional Activities Committee, and of the Task Committee on Headquarters Location has been given in the preliminary part of this report. Reports for the balance of the General and Task Committees follow:—

Advance Planning

G. C. Winkler, Chairman

The committee held only two meetings during the year. By correspondence and subsequent agreement by the committee, the following recommendations were submitted to Council:

1. That a committee be appointed to study the desirability of starting in 1961 to 1965 the holding of area or zone meetings in place of the present Regional Conference.

2. That the National Conference Papers Committee seriously consider leaving approximately an hour open in the Technical Session Program. This open hour would be filled by one or more good papers from a recent Regional Conference.

3. That the National Technical Conference Papers Committee find some means to extend acceptance date of papers to a date not more than three months prior to National Technical Conference date.

4. That the *IES Lighting Handbook* be published on a continuous basis — by revising and rewriting sections as they become obsolete.

Advisory Board to the President

G. J. Taylor, Chairman

The Board met several times and submitted to the President and President-Elect recommendations on organization, chairmanships, and personnel of committees.

Allied Arts

Karl Staley, Chairman

New and more courageous approaches to Allied Arts activities were evident this year. The committee assisted two new groups to organize. Under the direction of Lucian Kight, Pittsburgh Section conducted two programs at Penn State University. The first in the fall of 1957 culminated in a one-day visit to Nela Park's Lighting Institute.

An international flavor, heretofore supplied by the University of Manitoba, was retained by the interest of the Department of Architecture of Waseda University, Tokyo, Japan. Programs for both day and night classes were conducted there.

The New York Section (Rollo Gillespie Williams, AA Chairman) introduced a collaborative at Pratt Institute, teaming up interior design students and architects. Also new was the division of Pratt, Columbia, and Cooper Union activities into more or less separate entities. Prizes and judging were separate for the three schools.

Philadelphia Section (George Shoemaker, piloting) had another three-way program with University of Pennsylvania, Drexel University, and T-Square Club students competing.

Joint sponsors the American Institute of Decorators and the New Eng-

land Section (Eugene Frost, AA Chairman) assembled three schools this year, thus enjoying a more complete program in their second year of activity. The schools were Boston Architectural Center, School of Fine and Applied Arts, and Boston University.

A new approach to lighting education under the Allied Arts program was planned and executed by John Flynn, Cleveland Section AA Chairman, and Prof. William Gould of Kent State University. Their plan included several weeks of student "research" in lighting effects by means of models, followed by a five weeks' problem (a small exhibition gallery) to which the findings were applied. Scale models of the gallery were included in the program.

Robert W. Brown, Allied Arts Chairman of Ohio Valley Section, with the help of Chairman Staley conducted a two-day seminar at the University of Cincinnati this spring. Two groups of students of University work-study regime had five weeks to solve the problem, a small museum.

A combination of favorable circumstances made it possible to show all Section and Chapter winning drawings to American Institute of Architects' conferees who visited Nela Park on Monday, July 7, as part of their 101st Annual Convention. Considerable interest was aroused and some leads for exploring uncharted areas were uncovered.

During the year, a considered but not yet fulfilled project was the preparation of lighting lectures for the universities. The committee recognizes both the special needs of these students and the inherent difficulty of getting such material by qualified persons.

Board of Nomination

D. M. Jones, Chairman

In accordance with the Constitutional provisions and following the procedure adopted by Council, the Board was formed with three Past-Presidents of the Society and representatives of each of the eleven Regions. The Board reviewed extensive records of candidates as submitted by the respective Regional Nominating Committees, and from these prepared a nomination ticket containing names of those deemed best suited to serve as officers and directors in the positions to be filled at the ensuing election.

Constitution and Procedures

R. F. Hartenstein, Chairman

The committee prepared a final draft of the revised Constitution, taking into consideration all of the suggestions proposed by Council, and submitted it to Council for letter ballot in December. At the February Council meeting this final draft of the Constitution was approved by Council and was approved by a vote of the membership, effective October 1, 1958.

After the Constitution was approved by Council, the committee immediately started to work on the re-drafting of the By-laws. At the February meeting of the committee, the first draft of the proposed By-laws, prepared in accordance with the revised Constitution, was reviewed by the committee. As a result of this meeting the second draft of the proposed By-laws was prepared.

It was also agreed that since the Council Executive Committee, Headquarters staff and several other committees of the Society were vitally interested in certain sections of the proposed By-laws, related sections of the second draft were sent to the respective groups for review and comment.

On May 1 the committee met in Kansas City and again revised the proposed By-laws. The committee then sent to each member of Council the third revision for comment and suggestions.

At the committee meeting on June 3 all comments and suggested revisions were considered by the committee and the fourth revision was presented to Council on June 4, which was approved, with minor revisions, for letter ballot. Subsequently, this fourth draft was approved by Council letter ballot.

Defense Coordinating

J. W. Bateman, A. F. Wakefield, Co-Chairmen

This committee continues to provide means for Defense agencies to use professional counsel in illumination. Sixteen projects have been handled since the committee was established.

Historical

S. G. Hibben, Chairman

Of the ten projects scheduled in the committee program, the following were active during the past year:

1. Several books were added to the memorial library.

2. A design of the official badge was painted and deposited at Headquarters, with color-coordinates, and descriptions. Sections and chapters were advised of proper usage.

3. Biographies of prominent lighting persons were continued, as was also the editing of the extensive material for the History of Lighting Fixtures.

4. Two more disc records of Past-Presidents were completed. A Past-President's badge and certificate were presented with ceremonies to Mrs. Marks, widow of Louis Benedict Marks, the First President.

5. Meetings with the Thomas A. Edison Foundation particularly on the historical treatment at the Edison birthplace, Milan, Ohio and burial place, in New Jersey. Other marker-tablets are being listed.

6. Joint operations were furthered with the Electrical Historical Foundation, towards exhibits at Greenfield Village, Dearborn, Michigan.

7. Each month a short article was printed in ILLUMINATING ENGINEERING, under the heading "Leaves From the Historical Committee Scrapbook."

Lighting Service

C. W. McCormick, Chairman

1. The committee reviewed the contest rules for Section and Chapter contests and for Regional and National contests. As a result the rules were re-printed in new form by photo-offset, one for Sections and Chapters and one for Regional and National contests.

2. As a second task, the committee re-studied its scope, and following report to Council, approval was given to a re-statement as follows: "To stimulate and promote the discussion of practical applications of lighting recommendations."

3. To cope with the general feeling that the membership was losing interest in MMILJ Contests, the committee studied methods of giving the contest complete membership coverage. This resulted in a full page insert in the monthly journal, the December 1957 issue of ILLUMINATING ENGINEERING.

4. The committee studied the problem involved in the judging of oral presentations. Many members felt that the oral presentation had too much influence on the judges. The committee is studying these problems in two

channels: (1) Discuss and make recommendations for Lighting Service Forums at Regional and National Technical Conferences, and, (2) Discuss and make recommendations for changing entry blanks including enough information to permit judgment without oral presentation.

5. The committee compiled suggested changes and additions to the contest rules submitted by the membership. These were studied and the committee adopted four changes or additions for the 1958-59 rules.

6. The committee received reports in a total of 31 contests held at Section and Chapter level.

7. The committee concluded the year by conducting the National MMILJ contest in the Lighting Service Forum at Toronto in August 1958.

Membership

Brooks Chassaing, Chairman

The 1957-58 Committee adopted for its goal the same principles as in effect the previous year, namely that of increasing the membership of the Society through the addition of new members in sufficient quantity to more than offset the annual loss in membership that occurs due to deaths, retirement from business or changes in business and professional affiliation. The committee continued its efforts to increase in ratio the number of Member Grade to Associate Member Grade.

The committee consisted of its Chairman, plus the addition, this year, of an active Vice-Chairman, James C. Forbes, and a Regional Membership Representative from each of the Society's eleven Regions.

At the start of the fiscal year the committee, with the approval of Council, appointed a special Task Committee under the Chairmanship of Gerald Marks, to initiate a study of means and methods whereby present members of the Society may find a greater interest and value from their membership.

As in previous years an active Membership Campaign was conducted throughout the year with the Sections and Chapters being divided into four groups, based on membership at the start of the fiscal year. The campaign was again conducted in two parts — one being directed towards Gross Gain in membership and the other towards Net Gain in membership. Each month detailed reports were mailed to all Sections and Chapters.

Again, as in the previous year, the committee expanded its membership campaign to include a contest among the eleven Regions of the Society and this was also conducted in two parts — Gross Gain and Net Gain.

The Vice-Chairman of the committee was assigned the particular task of working with the Sections and Chapters in keeping losses, especially through non-payment of dues, at a minimum.

During this fiscal year the Regional Membership Representatives played a much larger part in the conduct of membership activities within the Regions which they represented. Several of them made exceptional contributions to the Society through their regular and most interesting monthly reports to the Sections and Chapters within their Region.

In July, 1957 each Regional Vice-President was asked to canvass the Sections and Chapters within his Region in order to make a studied appraisal on the potential for new members for the year 1957-58. Each Regional Vice-President complied with the request and their findings played an important part in setting the goal for new members nationally.

In August, 1957, the committee prepared and then mailed to all Section and Chapter Membership Committee Chairmen two brochures. One was entitled "How to Build IES Membership Within Your Section or Chapter" and the other was entitled "Categories of Prospects for IES Membership."

In October, 1957, all Section and Chapter Membership Committee Chairmen were asked to submit to the National Committee an outline of the programs and plans they were making locally to increase the membership of the Society.

In October, 1957 each Section and Chapter was given a series of five brief statements which they were asked to have printed on their meeting notices each month starting in November or December. These statements, one to appear each month, stressed some of the advantages to be gained through membership in our Society.

During the fiscal year the National Committee directed five general letters to the Regional Vice-Presidents; six general letters to the Regional Membership Representatives; eight general letters to the Section/Chapter Chairman and 14 general letters and Campaign Reports to the Section/Chapter Membership Committee Chairmen. The National Committee had the cooperation of the Executive Secretary and his office in the excellent services rendered in having these general letters and reports printed and mailed.

During the fiscal year the National Committee received exceptional support through the publications of three open letters to all Society members in our official journal ILLUMINATING ENGINEERING in addition to the several 'plugs' given through our Advertising Manager. The National Committee is indebted to our Editor and our Advertising Manager for their support and encouragement.

At the close of the Membership Campaign, the National Committee was happy to report to the Society that total membership has now passed the 9000 mark, and that losses this fiscal year, for all reasons, compare favorably with the record of previous years. The committee also reported a very encouraging gain in the number of elections to Member Grade.

Prizes for the winners in the 1957-58 Membership Campaign were announced at Toronto, Canada on the occasion of the National Technical Conference, as follows:

Classification	Gross Gain Winner	Net Gain Winner
Regions	Southwestern Region	Southwestern Region
Group I	Golden Gate	Golden Gate
Group II	Rochester	Rochester
Group III	Southeast Florida	Miami Valley
Group IV	Panhandle	Panhandle

National Technical Conference

Charles L. Amick, Chairman

Following the pattern for selecting National Technical Conference locations in specific Regions at certain intervals, the Committee acted favorably on the invitation from the North Texas Section to hold the 1962 Conference in Dallas. This recommendation was approved by Council. Locations for the next few years are as follows:

1959 — San Francisco
1960 — Pittsburgh
1961 — St. Louis
1962 — Dallas

A Task Committee was appointed to study the scope, general objectives and the long-range importance of Na-

tional Technical Conferences with regard to the total program of the Society. This subcommittee has not yet rendered its report.

Public Relations and Information

James R. Chambers, Chairman

During 1957-58 distinct progress in advancing the Society's Public Relations and Information program has been made in two areas: (a) In advancing the recognition and stature of the Society through publicizing the work of its committees, researchers and individual members; (b) In taking basic steps towards improving its lines of communication between the Sections and Chapters and their local publics, and between Sections and Chapters and the Society's headquarters in New York.

(1) The 1957 National Technical Conference commanded record space in newspapers throughout the southern tier of states as well as in major cities on both coasts and in the midwest. Radio and TV coverage equalled that of the Anniversary Conference in Boston the previous year and exceeded all previous years' coverage by the time the 1958 Regional Conferences were completed. President Reid made several TV appearances, including one that marked the establishment of a new chapter in London, Ontario. Several speakers at regional conferences, notably in Rochester, Portland and Salt Lake City, were featured in live or transcribed radio programs. Similar coverage was given by radio stations in Pittsburgh to a Forum in February.

The semi-annual meeting of the Aviation Lighting Committee at Wright Field developed information which became the basis of a subsequent press conference in New York which was reported by the electrical and automotive trade press. Aviation writers for both the Associated Press and International News Service printed extracts from the resultant article in Automotive News. The Light and Vision Course conducted at the University of Michigan's School of Public Health, Ann Arbor, during the winter, also developed considerable consumer and trade press coverage.

(2) Aside from this form of public relations activity, the committee brought to the final stage a Guide for local chairmen, committeemen, officers and interested members. This Guide is designed to sharpen the contacts of Sections and Chapters with their local press and other home-town media of communications.

Residence Lighting Forums

Virginia Skinner, Chairman

Three committee meetings were held in New York at Society Headquarters to plan for (1) the program at the Toronto Conference, (2) a brochure designed to stimulate interest in new Forums, (3) publicity and exchange of information about successful programs and activities.

New Forums — One new Forum was organized this spring in Washington, D. C. Officers were elected and meetings were planned for the fall. Other sections considering the formation of a Forum group are: Kansas City, San Francisco, Southern Cailfornia, Cincinnati, and Pittsburgh.

Membership cards — At the suggestion of the Twin City Forum, membership cards were designed for the use of all Forums. These were printed and are now available at Headquarters office.

Brochure, "Why IES Residence Lighting Forums?" — One of the most important achievements has been the publication of this brochure. The purpose of this brochure is to encourage the organization of new Forums. It will be sent to key people in the industry. The project was in the charge of Mary Webber and Lloyd Gabler who contributed their efforts and talents in the preparation of this material.

Forum Article — An article on Residence Lighting Forums with pictures of all Forum Chairmen was published in ILLUMINATING ENGINEERING in April 1958. This presented a good over-all picture of Forum procedure and activities.

Programs — Program subject matter included: Panel discussions with architects, decorators, builders, lamp and fixture dealers, lighting tools for the designer, Christmas workshops, garden lighting, and other timely and interesting topics.

MMILJ Competition — An increased interest in the residential division of the lighting competition has been indicated by program reports from various Forums. Several groups devoted an entire meeting to the competition and one Forum had as many as six entries.

Outstanding Events, Lighting Conferences — Two Forums, Detroit and Twin Cities, held very successful all day conferences for builders, architects, decorators, electrical contractors, and lighting specialists. Speakers included some of the best known authorities on lighting in the country. Attendance at these two conferences set a record with 592 present.

Forum Membership and Attendance — There were 33 more paid members than the previous year, and totals show an increase in attendance at meetings of 217. A summary of the attendance, membership and meetings of each Forum is given below:

Forum	Membership	Meetings	Attendance
Arizona	50	7	275
Georgia	104	8	513
North Texas	70	4	243
Michigan**	121	4	328
New York	143	8	549
St. Louis	61	6	238
Tenn. Valley	54	2	110
Twin City**	47	2	575
Utah	50	4	121
Washington, D. C. (new)	—	—	—
	700	46	2952

Note: Chicago was inactive during the past year.

**These figures include the lighting and design conferences held for members and others in allied fields.

Student Membership

John O. Kraehenbuehl, Chairman

The general objective for the year was to establish new Branches and to increase the student membership. Action was initiated by the circularizing of the Section and Chapter Chairmen of the Society with a letter. The response to this letter was very weak with only two individuals volunteering to contact schools for the stimulation of interest in forming Student Branches.

To each volunteer, the committee sent material abstracted from the Constitution and By-laws regarding the organization, responsibility and status of the Student Branch. Also at the same time material was sent suggesting means for establishing and stimulating Student Branches.

According to records at Headquarters, the following Student Branches continue active:

University of Illinois
University of Miami
Southern College of Optometry
Oregon State College

The committee was requested by

Council to cooperate with the Regional Activities Committee and the Constitution and Procedures Committee in submitting a revision covering all Student Membership activities and Branches. The committee prepared such material as requested.

The year's activity definitely shows that there is little interest in the Society concerning student membership or Student Branches. Either the Section and Chapter Chairmen have not presented the material to their memberships, or if it was presented, the members of the Society showed no interest in stimulating the forming of Branches.

Sustaining Membership

C. C. Keller, Chairman

The activities of the committee during 1957-58 have been devoted largely to maintaining good-will and interest on the part of existing Sustaining Members. Five mailings were sent to all Sustaining Members, from President Waterman with the Annual Research Report, from President Reid concerning the Society program, from the chairman with the 1957 Progress Committee Report, and later, Introducing the Candidates, and the fifth from President Reid with a brochure describing the research program of the Illuminating Engineering Research Institute.

A study was undertaken to determine the practical income objective in the future and the committee recommended that this objective be set at $100,000.00 annually, in the relatively near future.

The committee also recommended that a dues formula be established for all segments of the lighting industry.

The committee likewise recommended a revision of national committee personnel and direction of effort. Recognizing that sizable numbers of Sustaining Members are located in only twenty of the 82 Section and Chapter centers, it was proposed that local Sustaining Membership Chairmen from these twenty areas be enlisted in the national committee; that information on Sustaining Membership be available to all 82 Sections and Chapters, but that national committee and its effort be directed to the national program, and these twenty important areas.

The committee was asked to consider the matter of Official Representatives. The committee reported its opinion that it is the responsibility of the Sustaining Member to designate any person it wishes as Official Representative; that it is the responsibility of the Official Representative to keep top management informed about the Society.

The Section and Chapter program continued successfully in its service to present Sustaining Members, and in the addition of a sizable group of new members. The local Sustaining Membership Chairmen who were especially successful included:

Paul F. Kauffman	Chicago Section
William C. Mutchler	Cleveland Section
Francis Clark	Connecticut Section
Thomas E. Smith	Forest City (London) Chapter
Chester Kuzniar	Hamilton, Ontario Chapter
Richard Holcombe	Iowa Section
Meyer H. Silverman	New York Section
Sam Rutledge	Panhandle Chapter
G. William Wagner	Philadelphia Section
Robert E. Watson	Rocky Mountain Section
Roy Dahlin	Southern California Section
Gordon Wells	Tar Heel Section
W. D. Anderson	Twin City Section
Phil Smith	Utah Section

The final figures for the year reflect not only the gains achieved by the Sections and Chapters but also the losses due to resignations and dues decreases, resulting from the economic situation. The closing figures are shown in comparison with those for recent years.

	Members	Dues Income
1952	335	$41,735.
1953	334	40,735.
1954	336	40,635.
1955	334	43,391.
1956	414	63,893.
1957	452	66,402.
1958	448	64,815.

Tellers

S. A. Bogen, Chairman

In accordance with Constitutional provisions the committee met following the close of the election ballot and counted the vote both on the National and Section offices. In this the committee had the customary assistance of headquarters personnel both in the preparation of the forms and reports, as well as in the opening of the ballots and the making of a preliminary count.

Trustees
Headquarters Retirement Plan

R. F. Hartenstein, Chairman

The Trustees of the Plan held their regular annual meeting at the time of the National Technical Conference in Toronto. The customary formal record was made covering the operation of the Plan during the fiscal year just completed.

Joint Task Committee,
I.E.S.-U.S.P.H.S.

J. F. Parsons, Chairman

The report of this Task Committee, "How To Make A Lighting Survey; A Vision Survey," was accepted as a progress report by Council in 1955. A survey has indicated a probable demand sufficient to justify publication. The draft is now undergoing revision to bring it technically up to date. Immediately following completion of work on the third edition of the *IES Lighting Handbook*, the committee will undertake reworking the material into its final form.

Sign Lighting, Task Committee

C. N. Laupp, Chairman

Task Committee on Sign Lighting has completed revision of the *IES Lighting Handbook* material. Membership of committee is being expanded to include personnel from Outdoor Advertising Association and National Sign Association. Answers to a questionnaire being sent out will determine what future action and studies will be taken.

Technical Committees

Aviation

L. C. Simpson, Chairman

The committee held its fall conference at the Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, where 80 persons registered for the two-day meeting. The very interesting and instructive program included papers on aircraft and aviation ground lighting, effects of acceleration on vision, and the environmental testing of equipment. Tours were conducted through the laboratories to witness testing procedures, and the Grimes Manufacturing Company plant in Urbana, Ohio, was visited.

The spring meeting of the Aviation Ground Lighting Subcommittees was held in Washington in the offices of the Civil Aeronautics Administration followed by a dinner meeting and inspection of the newly-installed fluorescent floodlighting on one of the runways of the Washington National Airport. Considerable progress was made

toward the preparation of new requirements and practices for aviation ground lighting.

The spring meeting of the Aircraft Lighting Subcommittee was held in Hollywood, California, and the 70 persons registered heard papers given on high altitude lighting and the requirements and evaluation of interior and exterior aircraft lighting systems.

Because of the growing interest in improved systems of aircraft and aviation ground lighting systems to cope with the operational requirements of faster and higher altitude aircraft, consideration is being given to the reorganization of the committee structure to permit an expanded program, adding material interest and increased membership.

Color

R. C. Allison, Chairman

A subcommittee of the main committee prepared and submitted material for the related sections of the third edition of the *IES Lighting Handbook*.

Daylighting

H. B. Vincent, Chairman

A meeting of the committee was held on September 11, 1957 at Atlanta, Georgia, with 16 members and four guests in attendance. Reports were received from all subcommittee chairmen. A final report from the subcommittee on Lower Ceiling Classrooms, circulated during the year, had received comments requesting a few changes in wording. A revised text was presented at the meeting and approved unanimously by the committee.

Tentative arrangements were made for a meeting of the committee in 1958 for discussion of a revision of Recommended Practice of Daylighting following completion of a text by the subcommittee organized for its preparation.

Several subcommittees were continued as follows:

Coordinating Subcommittee—Chairman, R. A. Boyd. No matters requiring the attention of this subcommittee have arisen during the current year.

Lower Ceiling Classrooms—Chairman, H. F. Kingsbury. During the year, copies of the final report as approved at the Atlanta meeting were submitted to Council.

Revision of Recommended Practice of Daylighting—Chairman, R. W. McKinley. In a meeting at Pittsburgh on March 18, 1958 the text of a revision was approved unanimously by the subcommittee. Recommendations were based on applicable criteria for lighting requirements as currently approved and published by the Society. In the light of the results of research presented by Professor H. R. Blackwell at a joint meeting of the Committee on Quantity and Quality of Illumination and the Illuminating Engineering Research Institute at Dearborn, Michigan on March 3, 1958, further activity was suspended pending clarification of criteria.

Availability of Daylight (Exterior)—Chairman, B. F. Greene. A proposal has been prepared for discussion at a meeting of the committee outlining a format for systematic assembly of data for daylighting design purposes. One of the subcommittee members, Dr. R. A. Boyd, published "Studies on Daylight Availability" as a University of Michigan bulletin, March 1958.

Design Practice

George W. Clark, Chairman

Activity of this committee has been almost completely devoted to revision of *IES Lighting Handbook* Section 9 "Lighting Calculations." The basic manuscript has been approved and submitted. Some editorial details and the completion of the illumination table remained to be done at the close of the year.

Education

Alston Rodgers, Chairman

As a result of arrangements made early this year, representatives of the National Science Teachers Association have reviewed the text and illustrations for the committee's report, "Experiments With Light." Their board has approved inclusion of the statement that this booklet was developed by the Society with the cooperation of the National Science Teachers Association. On their recommendation, the title has been changed to "Activities With Light," to correspond with modern teaching terminology.

The subcommittee, Carl Zersen, Chairman, for the revision of lighting courses, to be sponsored by Sections and Chapters, has turned in a great amount of excellent work this year. The new lighting course publications will be larger, more comprehensive and better illustrated than those they replace. First draft of the "Lighting Fundamentals Course" has been completed by the task group headed by Ray Wozniak, Chairman, and copies have been sent to all committee members for review. "The Advanced Lighting Design Problems Course," being prepared by Ralph Lusk, Chairman, and his task group, will be ready for committee appraisal toward the end of the year.

Handbook Revision

John J. Neidhart, Chairman

Publication of the revised *IES Lighting Handbook* is now scheduled for March 1959. The reorganized, easier-to-use Handbook will be filled with up-to-date information including recommended illumination levels based upon the recently completed Blackwell Research.

I.E.S. - A.S.A.E.

Morris Lloyd, Chairman

This committee, which was formerly the Farm Lighting Committee was in process of re-organization during the year in its joint effort with the American Society of Agricultural Engineers.

I.E.S. - A.S.H.A.E.

A. T. Jorn, Chairman

Studies were continued on the "Thermal Aspects of the Lighting System" in anticipation of a report analyzing the contribution which electric lighting and daylight make toward the required heating system for a building.

Industrial

W. H. Kahler, Chairman

The Industrial Lighting Committee consists of nine members, including the Chairman and Vice-Chairman. In addition, there are seven subcommittees working on a revision of the recommended practice of industrial lighting, and six different manufacturing industries. The six industry subcommittees cover Aircraft Manufacturing, Clothing Industry, Graphic Arts Industry, Outdoor Productive Areas, Electronic Industry, and Wood Working Industry.

The committee's activity during the past year consisted primarily of finishing revision material for the *IES Lighting Handbook* and developing the new illumination level tables for the Handbook. The latter entailed close collaboration with the Committee on Recommendations for Quantity and Quality of Illumination, which was charged with the responsibility of interpreting the Blackwell Research data. The industrial part of the Handbook illumination table covered over 400 separate industrial areas. The seeing tasks in these areas were related to the actual tasks studied in the Blackwell Research project. The results are a completely new set of recommended values of illumination for all industrial areas.

The new table was completed and approved by the committee and submitted to Council for inclusion in the *IES Lighting Handbook*.

Institutions

Leonard V. James, Chairman

The "Lighting for Hotels" report of this committee, through its subcommittee on Hotel Lighting, Prof. C. I. Sayles of Cornell University School of Hotel Administration, Chairman, appeared in the July 1958 issue of ILLUMINATING ENGINEERING. The other subcommittees, on Art Galleries and Museums (J. M. Ketch, Chairman), Churches (George E. Shoemaker, Chairman), Dining Areas (C. W. Zersen, Chairman), and Hospitals (N. L. Griffin, Chairman) are working on their final reports which, however, could not be completed in the 1957-58 Society year.)

All of the committee, of 39 members total, have devoted much time to preparing final copy and recommended footcandles for the revised *IES Lighting Handbook*. The subcommittee on Theatre Lighting has been transferred to the Theatre-Television Committee, under the previous subcommittee chairman, Joel E. Rubin, as chairman.

Light Control and Equipment Design

John J. McLaughlin, Chairman

The work of this committee consisted of revising Section 6 of the *IES Lighting Handbook* and preparing material for a Guide Book on Light Control and Equipment Design.

The committee had four meetings during the year and submitted the following reports to Council for approval:

1. Recommended Light Characteristics of Polystyrene Used in Illumination.

2. The IES Guide to Design of Light Control.

3. Design of Reflector and Optical Elements.

Section 6 of the *IES Lighting Handbook* was revised and submitted for publication.

Light Sources

G. A. Freeman, Chairman

The committee held two meetings and engaged in large scale correspondence to successfully complete the revision of Sections 1 and 8 of the *IES Lighting Handbook*.

A resolution was prepared from the viewpoint of the lamp and lighting industry evaluating the proposal for Higher Utilization Voltages by the Edison Electric Institute and the National Electrical Manufacturers Association. This was presented at a symposium of the AIEE Committee on Safety.

Assistance was given to the Society's Nomenclature Committee with suggestions for Light Sources Nomenclature.

Further progress was made on:

1. The accumulation of data for continuing the Question and Answer page in ILLUMINATING ENGINEERING.

2. The report on the effect of high and low ambient temperatures, drafts, etc., on the starting, light output and color of fluorescent lamps.

3. The work of the subcommittee, under Miss Dorothy Nickerson, Chairman, on the development of a method of measuring and specifying the color rendition properties of light sources.

Maintenance

Francis Clark, Chairman

The three basic factors which affect maintenance of usable light in any lighting installation have not changed since the report of this committee in 1957. However, it has become apparent that the task of accumulating data from Dirtometer testing, and assimilating it, is a formidable one, requiring much time and considerable technical ability and equipment.

During the past year, the committee has agreed upon a fairly simple, yet complete and thorough "Maintenance Tests Data of Lighting Installations" form which combines plotted footcandle readings with descriptions of fixtures, lamps, and surround. The only equipment required is a light meter. These forms will record the general depreciation of light in a given test area. From this can be subtracted the known lamp depreciation to arrive at the amount attributed to accumulation of dirt on luminaires, lamps, and surround.

Forms have been sent to several Society committees in hope that widespread use will result in data which can be correlated and become useful for any committee.

It is realized that data collected in this manner will not match, for accuracy, that obtained from Dirtometer testing. However, it is expected that the improvement in speed and volume of data returns will provide valuable information more quickly. Continuing Dirtometer returns will ultimately supply the technical accuracy required for corroboration.

Motor Vehicle (Exterior)

Ray P. Teele, Chairman

The study of the lighting of the rear of motor vehicles was continued during the year. An interim report is in course of preparation and will suggest steps to be taken for improvement of signal indications from the rear lights of motor vehicles.

Nomenclature

Priscilla Presbrey, Chairman

The Committee on Nomenclature met twice during the 1957-58 year, continuing work on the revision of ASA Z7.1 - 1942, Illuminating Engineering Nomenclature and Photometric Standards. Since completion of this task will still require some time, it was decided to make available, by publishing them in ILLUMINATING ENGINEERING, those sections which have been revised since 1942. Five current sections appeared in the November, 1957 issue: 05, Photometric Quantities, 10, Radiation, 20, Color, 30, Characteristics of Surfaces and Media for Controlling Light and 50, Aeronautic Lighting.

Council approval has been given to a refinement in the definition of "candle," and to the adoption of the terms "luminous efficacy" and "spectral luminous efficiency," replacing the former

"luminosity" and "luminosity factor." Progress has been made on the revision of Section 15, Ultraviolet Quantities, and Section 25, Light Sources. In addition to these, the committee is actively considering the following: adoption of the term "candela," in accordance with international practice; addition of a new section on the predetermination of illumination and photometric brightness values, made necessary by rapidly growing activity in this field; inclusion of more definitions in the various application fields; and a rather complete reorganization of the nomenclature along lines indicated by developments since the issuance of the 1942 edition.

Office

G. Franklin Dean, Chairman

All activity of the current year was concerned with footcandle values for the new edition of the *IES Lighting Handbook* to be published in 1959.

As an ex-officio member of the Committee on Recommendations for Quality and Quantity of Illumination, the Chairman attended the three meetings of that committee held at the University of Michigan to study the technique and results of the Blackwell Research on Quantity of Illumination.

Following the formal presentation of his studies by Dr. Blackwell at Dearborn in March, the Office Lighting Committee met to determine new footcandle levels for the various types of office work based on the findings of Dr. Blackwell's research. This meeting was held part-time with the School Lighting Committee to avoid conflict in interpretation of the research results.

To the Office Lighting Committee was also assigned the task of preparing tables of illumination levels for Banks; Depots, Terminals and Stations; Municipal Buildings (Fire and Police); and Post Offices.

The proposed values were submitted for letter ballot to the committee members. Majority approval being given, the tables of footcandle values were forwarded for approval by Council.

Progress

E. A. Linsday, Chairman

The committee maintained contact with the art of lighting throughout the world and prepared the yearly review of the achievements in the art of lighting for publication in ILLUMINATING ENGINEERING. This review was given a dramatic presentation as one of the features of the 1958 National Technical Conference in Toronto.

Public Conveyances — Interior Lighting

Ernest Boghosian, Chairman

The final draft (Number 6) of the "Recommended Practice for Marine Lighting" was submitted in October for Council approval.

Recommended footcandle values for land and marine transportation visual tasks were reviewed on the basis of information contained in Report Number 1 of the Committee on Recommendations for Quality and Quantity of Illumination. Changes in these recommended values were forwarded to the Technical Director's office in April, 1958.

Quanity and Quantity of Illumination —Recommendations for

B. S. Benson, Jr., Chairman

The principal work of the committee during the year was the preparation of a report which is the interpretation by the committee of the Illuminating Engineering Research Institute's research on quantity of illumination by Dr. H. R. Blackwell and associates at the Vision Research Laboratories of the University of Michigan.

The report was used by the technical committees in determining their recommendations for various categories of applications such as Offices, Industrial, Institutions, Stores, Residential and Public Conveyances, and published in the August 1958 issue of ILLUMINATING ENGINEERING.

Residence

Frank J. Marriett, Chairman

Subcommittee work for the revision of "Contemporary Lighting in Modern and Traditional Interiors" is nearing completion. The re-titled booklet will be a complete revision including illustrations and will be ready for publication early in 1959.

"Outline for Training Program" will also be completed and ready for publication early in 1959. This is a well-organized guide for organizing a training program on residence lighting.

Roadway

Dana W. Rowten, Chairman

The work of this committee is subdivided and assigned to sixteen subcommittees. Each subcommittee is headed by a chairman and supported by two or more committee members, as considered necessary for the most efficient operation.

All subcommittee reports, after approval by the subcommittee, are submitted to the main committee for consideration. If and when a report is approved by the main committee, it is forwarded to Council for their approval, and in some instances on to the Standards Committee. The following is a brief report on the status of some of the most active subcommittees.

Tunnel and Underpass Lighting — Chairman, R. M. Swetland. The recommendation for Lighting Traffic Tunnels and Underpasses has been approved and published. The recommendation has been well received and will, in all probability, be included with the proposed revision of the American Standard Practice for Roadway Lighting.

Visibility Under Fog Conditions — Chairman, E. E. Paul. This previously reviewed research project has developed into a full scale demonstration installation on the New Jersey Turnpike.

Parking Area Lighting — Chairman, M. E. Keck. The principal responsibility for developing a recommendation for parking area lighting has been transferred, by Council action, from this committee to a subcommittee under the Store Lighting Committee.

Research—Chairman, D. A. Toenjes. This subcommittee coordinates for the full committee all the various research projects, both underway and proposed, that have not developed to a stage to justify a specific subcommittee.

The original Project #22, Pavement Surfaces, is at present nearing completion. The original data and an approved method of analyzing the data have been turned over to the Technical Director.

Low Mounted Luminaires — This subject comes up about every ten years. The Research Subcommittee is assembling all the data on this subject in one reference file, for possible publication in ILLUMINATING ENGINEERING as a matter of record.

Discomfort Glare Evaluator — The

research committee had an opportunity to use and become familiar with the principles of the new Discomfort Glare Evaluator at a meeting at Dayton, Ohio on May 27, 1958. The results of the evaluations made have not yet been analyzed sufficiently to pass judgment as to its practicability and accuracy.

General Light Source Committee—Chairman, J. W. Young. This subcommittee has continued to collect data on lamps from all manufacturers and consolidate the data for general use of the committee members and for publication in the *IES Lighting Handbook*.

Standard Practice Committee—Chairman, W. H. Edman. The work of this subcommittee is considered the most important of any subcommittee. However, its success depends upon the cooperation and contributions of all other subcommittees. The committee is in the process of evaluating hundreds of individual suggestions for changes in the American Standard Practice. The committee has promised to present a first draft of a revised Standard Practice for consideration of the whole committee at the next annual committee meeting.

School

J. M. Chorlton, Chairman

The principal work of the committee during the year has been in the completion of the related sections of material for publication in the third edition of the *IES Lighting Handbook*.

The committee has continued to review the proposed revisions in the American Standard Practice of School Lighting, 1958. The committee has received reports through the year on the deliberations of the joint Task Committee composed of the Society's representatives along with those of the School Committee of the American Institute of Architects and the National Council of Schoolhouse Construction, co-sponsors of the American Standard Practice of School Lighting.

Searchlight

J. P. Latil, Chairman

A subcommittee of the main committee prepared and submitted material for the related sections of the third edition of the *IES Lighting Handbook*.

Signal Lighting, Elements of

James F. Angier, Chairman

The committee reports no progress during the past fiscal year.

Sports and Recreational Areas

Wallace W. Weld, Chairman

The final revision of the Recommended Practice on Sports Lighting is currently being circulated to the committee. This includes the new sports layouts as well as the necessary changes and all those shown in the present Recommended Practice.

One factor which might be brought out at this time is the new mounting height chart which can be applied to practically all outdoor areas. Instead of having an individual mounting height chart for the various sports, this one chart will take care of all sports.

Store

Lester Geis, Chairman

Further work was done on the revision of the committee report "Lighting for Stores and Other Merchandising Areas." At the last meeting specific assignments were made in order to expedite completion.

The Subcommittee on Parking Areas and Service Stations has in final stages the draft of a report on parking area lighting practice.

This material was also submitted for publication in the third edition of the *IES Lighting Handbook*.

Testing Procedures for Illumination Characteristics

Phelps Meaker, Chairman

Progress has been made by this committee on its principal assignments. Although only one full two-day meeting has been held, effective work has been accomplished by the subcommittees as follows:

Guide for Electrical Measurements of Fluorescent Lamps—G. A. Meyers, Chairman. The introduction of new lamp types and the continuing study of measurement methods brings about a need for an early revision or addendum to include new information.

Guide for Photometric Testing of Indoor Fluorescent Luminaires (Revision of 1949 issue)—G. A. Horton, Chairman. The subcommittee will shortly consider the third draft of this guide.

Guide for Photometric Testing of Floodlights of 10 to 160 Degrees Total Beam Spread—J. S. Franklin, Chairman. New aspects as well as items in need of revision have been brought up, so that an extensive revision is being undertaken.

Guide for Use of Portable Photometers (Revision of 1937 Report)—G. A. Horton, Chairman. Work on this guide is in progress.

Guide for Photometric Testing of Outdoor Fluorescent Luminaires—J. S. Franklin, Chairman. This guide was published in ILLUMINATING ENGINEERING, February 1958.

Guide for Photometry of Searchlights—A. E. Kraweek, Chairman. This guide was published in ILLUMINATING ENGINEERING, March 1958.

Guide for the Photometric Measurement of Mercury Vapor Lamps—J. S. Franklin, Chairman. A sixth draft has been submitted to the committee for consideration. This guide is nearing the balloting stage.

Practical Guide to Photometry—R. D. Bradley, Chairman. The subcommittee is working actively on additional text material.

Guide for Reporting Lighting Equipment Engineering Data—E. H. Witte, Chairman. This guide was approved by Council at its April 1958 meeting.

Practical Guide for Brightness Measurements—Paul H. Lamson, Chairman. A new draft will shortly be submitted to the entire committee.

Guide on Colorimetry of Light Sources—Ray P. Teele, Chairman. The first draft will be considered by the entire committee at its next meeting.

IES Lighting Handbook Revision. Bibliography and illustrations for Section 4 of the Handbook were completed and turned over to the Handbook Revision Committee.

Theatre-Television

Joel E. Rubin, Chairman

A subcommittee of the main committee prepared and submitted material for the related sections of the third edition of the *IES Lighting Handbook*.

Views and Opinions

Recommended Levels And Lighting Practice

TWENTY years ago D. W. Atwater, in his presidential address, made a plea that illuminating engineers try to close the widening gap between knowledge and practice. His thesis was that light sources and equipment, as well as studies by IES committees, were getting farther and farther ahead of adequate utilization.

Some six years later, in my swing around the country as President of IES, I too stressed the need for relighting America in keeping with the tools we had then in equipment and knowledge, pointing out that knowledge was constantly expanding and that never would we be able to say that the job was finished.

As I looked over the exciting report of the RQQ Committee in the August 1958 issue of IE and the new and startling Recommended Footcandle Tables, I was reminded once more of Mr. Atwater's plea. If we have been far behind knowledge in our practice, these new concepts leave us shockingly trailing.

Granted that it is axiomatic that knowledge shall outpace usage and thus provide the stimulus for progress, and that new knowledge has to be tried out cautiously in order to gain sound public acceptance, the profession of illuminating engineering nevertheless has a responsibility made heavier than ever by the latest RQQ report and recommended levels.

If the recommended values are sound and practical, and, knowing the deliberateness with which the RQQ Committee has always worked in the past, I am sure they are, then the public has a right to enjoy the benefits thereof, not here and there but generally; not just in new monumental structures but in the old as well; not some time in the future but now.

If the Illuminating Engineering Society felt it advisable to accept this new report and these new values, then it will be remiss in its primary purpose (dissemination of knowledge) if it does not make a strong effort to secure reasonably quick acceptance of this knowledge in actual practice, far and wide.

Why were the new values of lighting levels accepted? Would they prove of some demonstrable value to users generally? What are these benefits and how can they be substantiated to the satisfaction of the public? Certainly the Society was not guessing, it must have sound reasons.

Here is a tremendous advance in lighting knowledge and if it goes the way of previous advances it will be enjoyed by the few and not by the many, at least by the time the next increase in values is published.

Let us try to do things differently this time. Let us start by educating the profession itself. Until the members of IES and all that great army of people contacting the public on lighting are thoroughly indoctrinated our job will be only partially done. In the past our profession has never fully and wholeheartedly accepted the new values. Far too many have been lukewarm and lazily independent of recommendations. It has been easier to meet a price than to sell the best. Good enough has been the path of least resistance.

I am thrilled to see the resolution with which the Society's committees advance these daring new concepts of illuminating values. I shall be disappointed if the new knowledge further widens the gap with practice. Light sources and lighting equipment adequate to the task are available and improvements are being made constantly. The weak link is the unbelieving, unindoctrinated, timid, complacent and self-opinionated members of the profession.

The public has the right to enjoy the advantages arising from this new knowledge. The profession has the responsibility to provide not only the knowledge but also the will to put it to work. — S. B. WILLIAMS, *Past-President, Illuminating Engineering Society, Jamestown, R. I.*

Changes in mailing address should be reported to IES Headquarters Office by the first of any month to ensure the uninterrupted mailing of IE and other Society communications.

Here and There With I.E.S. Members

Officers of all six Sections and Chapters in the East Central Region met at the Holiday Motor Hotel, outside Harrisburg, Pa. on September 26 to discuss local activities. Regional V-P, C. C. Shotwell, (seated seventh from left) presided. Also in attendance at the meeting was R. G. Slauer (to Mr. Shotwell's left), Society Vice-President.

Water skis, a life belt and a tow rope were presented to outgoing chairman Roy Bevan (second from left) at a recent meeting of the Southern California Section. Also shown here are, left to right, Edward Balogh, secretary-treasurer; (Mr. Bevan) James E. Barnes, South Pacific Coast Regional Veep; B. J. Hartmann, Vice-Chairman; Frank B. Lee Chairman.

Passing the gavel to his successor, John S. Frizell (right), at the start of a new IES year, is retiring Pittsburgh Section Chairman James A. Hodges. Watching the presentation is incoming Vice-Chairman, Warren Thayer.

Retiring Milwaukee Section Chairman William Kuhnke (right) accepts a certificate of appreciation from incoming Chairman Marshall Bruesewitz. Mr. Kuhnke was also presented with a gift at the meeting.

LIGHTING NEWS

U. S. National Committee Completes Plans, CIE Brussels

Final plans for U. S. participation in the quadrennial meeting of CIE (Commission Internationale de l'Eclairage) in Brussels next June, were made during the National Committee's annual meeting at State College, Pa., October 13-14. Actions taken at the two-day meeting included assignment of responsibilities of U. S. delegates at Brussels and appointments of American representatives to the sessions of Secretariats held by other countries; the report of acceptance and assignment of some 24 papers to be presented before the Brussels Congress, three (possibly six) by U. S. delegates; election of Members-at-Large to the U. S. National Committee; election of members to the CIE Executive Committee; and election of the USNC Executive Committee to serve for the next four years.

Unanimously elected to membership of the CIE Executive Committee were Herbert H. Magdsick and L. E. Barbrow. Three names were also added to the USNC Executive Committee by the election of Messrs. A. A. Brainerd, S. G. Hibben and R. C. Putnam to this body, of which H. H. Magdsick is President and L. E. Barbrow, Secretary. In addition to Mr. Magdsick and Mr. Barbrow, the USNC Executive body now includes A. A. Brainerd, W. C. Brown, S. G. Hibben, R. C. Putnam and T. D. Wakefield.

Very notable progress in lighting on the international level is expected to result from the meeting next June 14-25 in Brussels. Some 80 American delegates will attend, three of them presenting major papers before the international group. Simultaneous translation to the three official languages of CIE will facilitate the report by United States representatives assigned to sessions featuring papers from other countries; several caucuses will be held by the U. S. National Committee during the Brussels meeting to hear these reports.

The quadrennial meeting of this international group affords a most valuable opportunity for U. S. lighting experts to appraise lighting developments all over the world, and also to present to representatives from other countries major work done in illumination in this country. Considerable world-wide attention will be focused on the three American papers: "A Proposed General Method for Specifying the Quantity of Interior Illumination from Performance Criteria" by Dr. H. R. Blackwell; "Effect of Reflected Glare on Visibility" by D. M. Finch, J. M. Chorlton and H. F. Davidson; and "An Analogue Computer for the Predetermination of Luminance Patterns" by P. F. O'Brien.

All members of IES are invited to attend the Brussels congress. Anyone wishing to attend should notify A. A. Brainerd, Star Route, Erwinna, Pa., who heads the task committee on attendance.

3-Acre Garden Lighting Show Planned by San Jose Chapter

The success of the past two garden lighting shows, presented by the San Jose Chapter of IES, has resulted in plans for what promises to be a "super" show next year. The chapter has been joined by *Sunset Magazine* in sponsoring a two-week demonstration in the magazine's three-acre gardens in suburban Menlo Park.

The past two years saw relatively small shows — which were, however, highly successful — given at the homes of IES members George Harter and Rex Gardiner, under the chairmanship of Stan Blois and Howard Guilbert. Colored slides of this year's show, designed by Ed Dunckelmann, were sent to *Sunset*, the West's largest home and garden publication, with the resulting request by the magazine to co-sponsor the next one. The editor also sent photographers to this year's show for probable use on the cover of a future issue.

U. S. Educators Observe Soviet Engineering Schools

To study the much-discussed engineering schools of the Soviet Union, eight American engineering professors participated in an exchange mission on engineering education under the auspices of the American Society for Engineering Education. The group spent most of November in the U.S.S.R., visiting engineering classrooms and laboratories and meeting students and teachers throughout the country, including Siberia. They brought back to the United States curricula, syllabi, textbooks and other materials pertinent to Soviet engineering

January 30 Is Deadline For 1959 Conference Paper Outlines

The Papers Committee of IES has set a deadline of January 30, 1959, for outlines of proposed papers for the 1959 National Technical Conference. Outlines of proposed papers, in triplicate, should be mailed to:

Floyd W. Sell, Chairman, IES Papers Committee
c/o The Detroit Edison Company
2000 Second Avenue
Detroit 26, Michigan.

FROM Father to Son — Gavel and sounding block presented to R. L. Zahour (at right in photo at left), first Chairman of New Jersey Section. Making the presentation is Jack Hamilton, Chairman of the parent New York Section. Occasion was New Jersey Section Charter Night, October 18. In photo at right, IES President George J. Taylor as he gave inspiring (and frequently amusing) address before the Charter Night gathering. Seated, from left to right, are: Mrs. R. L. Zahour, New Jersey Chairman R. L. Zahour (hidden), Mrs. Taylor and R. L. Smart, Northeastern Regional Vice-President, who also participated in the evening's ceremonies.

education not formerly available in this country. Schools in Moscow, Kharkov, Novosibirsk, Tomsk, Stalinsk and Frunze were on the itinerary.

This educational exchange, originally suggested by the Russians, was a project of the Society for Engineering Education, conducted in cooperation with the East-West Contacts Staff of the U. S. State Department. A group of Soviet engineering educators is expected to tour technical schools in this country to complete the exchange program; however, plans for this phase have not yet been completed.

Dr. Frederick C. Lindvall, Chairman of the Division of Engineering at the California Institute of Technology was the head of the American exchange mission, with Professor Newman A. Hall, Chairman of the Yale University Department of Mechanical Engineering, serving as secretary.

New Jersey Section Celebrates Charter

Not since the Society's first year, 1906, has an IES group been launched full-grown, having Section status from the beginning. Such, however, is the case with the New Jersey Section, whose Charter was presented at its celebration dinner, and first meeting, October 15. The Section was created as the result of a poll conducted last Spring amongst New York Section members, giving a choice of membership in a new group in New Jersey, or remaining with the parent Section. With 10 Fellows, 68 Members, 107 Associates and 1 Student Member, for a total of 186, the new Section might be said to be very full-grown, indeed.

To celebrate the occasion, some 150 New Jersey members met for cocktails and dinner at the Essex House in Newark, N. J., on October 15, 1958. Presiding was the Section's first chairman, Robert L. Zahour, of Westinghouse Lamp Division, Bloomfield, N. J. Guest of honor, and chief speaker was IES President George J. Taylor, who presented the Charter to Mr. Zahour.

Two distinguished visitors to the meeting brought expressions of their organizations' best wishes. Governor of New Jersey (Robert L. Meyner-D) was personally represented at this Charter Night dinner by Mr. D. J. Henderson of the New Jersey State Highway Department. In his address welcoming the IES group to New Jersey, Mr. Henderson placed before them a very challenging suggestion, which in fact might be worthy of consideration for any IES Section. This was that the Section establish an individual street lighting group which could study highway lighting problems specifically as they relate to the laws, geography and climate of the state of New Jersey.

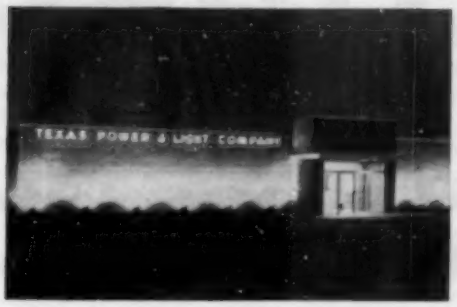
Another well-wisher to the new group was its own "daddy," in the person of John W. Hamilton, Chairman of the New York Section. Mr. Hamilton pre-

(*Continued on page* 15A)

NEW Fellows of the New Jersey Section receiving their certificates during Charter Night celebrations are, left to right: Svend W. Bruun, James L. Cox and R. L. Zahour. Northeastern Regional Vice-President, R. L. Smart, far right, made the presentations.

Revere Outdoor Lighting Report

Lighting a building exterior

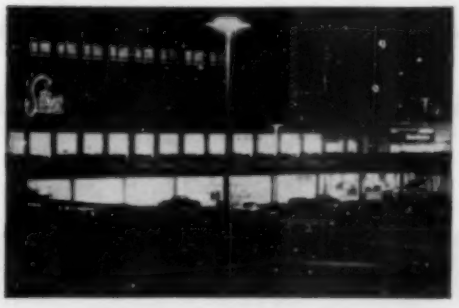


The Problem: To highlight a new building through the use of dramatic lighting of the building exterior. Fixtures must be attached to the building itself.

The Answer: Ten Revere No. 3151 Underneath Floodlights were installed to provide a source of uniform, glare-free light for the exterior walls of the building. Underneath Floodlights were chosen because they are unobtrusive and because they project a wide, flat pattern of light. Fixtures are completely weather-tight and insect-proof.

No. 3151 Underneath Floodlight

Lighting a shopping center parking lot



The Problem: To illuminate the large parking lot of a modern shopping center, providing a safe, attractive place for shoppers to leave their automobiles.

The Answer: Revere Ultra-Lites, multiple mercury luminaires, were installed throughout the parking area. The square light patterns were overlapped to achieve a uniform, glare-free light level. The use of Ultra-Lites cut pole requirements by more than 50% because of much higher utilization of light per fixture.

No. 5442 Ultra-Lite

Lighting a residential street

The Problem: To light a quiet neighborhood street with moderate-level illumination concentrated on the street with lesser amount on the sidewalk.

The Answer: Revere Urban-Lite luminaires were installed on one side of the street. Projection pattern of units made possible the even lighting of street and additional light on sidewalk with minimum stray light entering adjacent homes. Urban-Lite is an economical way to utilize smaller, highly efficient mercury lamps.

No. 2100 Series Urban-Lite

Write for Revere's complete catalog of outdoor lighting equipment

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new cool Sola ballast

easily passes "in-fixture" heat tests

coolest coils and capacitor give full ballast life

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MADE UNDER ONE OR MORE OF THE FOLLOW
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CANADIAN PAT'S. 439-590 (1947) AND PATEN
FOR 2-T12 40 WATT RAPID START LAM
CAT. NO. 670-109. HIGH P
118 VOLTS 0.80 AM
LAMPS MUST BE WITHIN 1" OF
SOLA ELECTRIC CO. CHICAGO, 5

Ballast for two 40-watt rapid-start lamps
Catalog Number 670-109

no price penalty for this premium performance

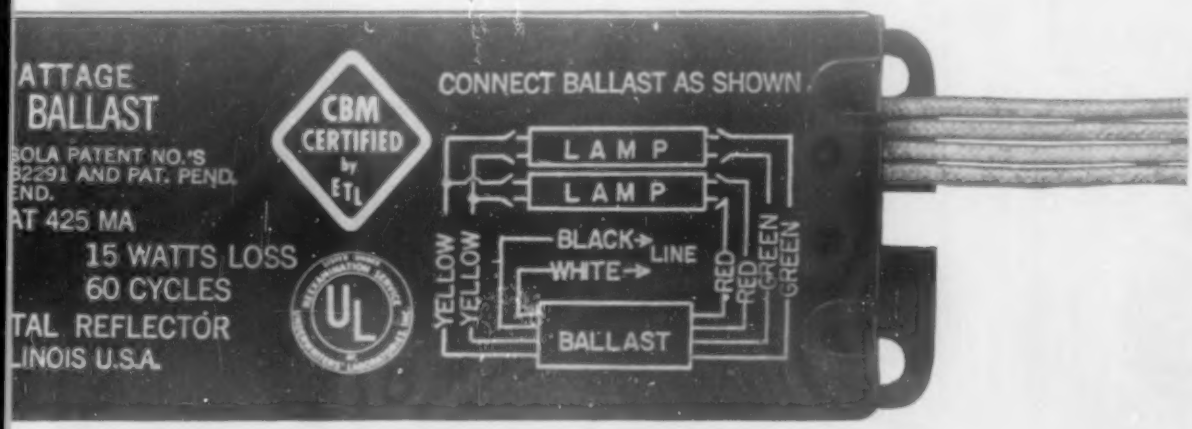
Now—totally new electrical and mechanical design sets highest standards of "in-fixture" ballast performance. This new two-lamp, 40-watt, rapid-start ballast is dramatic evidence of progress made possible by Sola's philosophy of conservative design. Sola views the ballast as integral with the lighting fixture and has consequently built its new ballast to pass exacting "in-fixture" tests and for actual operation under the most demanding conditions.

This new rapid-start ballast is designed to give only a 42°C coil-temperature rise when tested according to U.L. and E.T.L. methods. New circuitry increases ballast efficiency through reduced wattage loss.

The new ballast was tested in a four-lamp fixture, completely enclosed and surface-mounted on acoustical material. Temperature in the fixture channel was 18°C hotter than the usual 40°C ambient of U.L. and E.T.L. tests. Despite these severe test conditions, the following impressive results were recorded.

- *Maximum coil temperature was 89.3°C. This is 15°C cooler than the limit of Class A insulation.*
- *Temperature of the capacitor's case under this especially severe test was within the heat limits of the capacitor's insulation.*
- *The "hot-spot" temperature on the ballast case was 81°C. This is 5°C cooler than premium-priced ballasts similarly tested, and it is 9°C cooler than the maximum allowed under U.L. fixture requirements.*

This new level of cool ballast operation contributes to full ballast life. These improvements result from Sola's concept of ballast engineering that treats the ballast as integral with a fixture and part of the complete lighting system rather than as an isolated component. This approach has produced a major engineering breakthrough — the elimination of thermal insulating barriers which formerly confined ballast heat within the coil and capacitor compartment. Now, heat is far more easily dissipated through the case and fixture. The combination of fixture and Sola ballast now team up for cool, efficient, trouble-free operation.



Send for test ballasts or literature

Sola will furnish fixture manufacturers with samples of this new ballast. Write to us on your business letterhead, and a Sola sales engineer will promptly supply your test ballasts. Sola welcomes the challenge of having you evaluate this cool new ballast in your own fixtures. If you wish merely to examine data on the new model, please request Bulletin 3L-FL-352. Write to the Manager, Lighting Sales.

Sola Electric Co.** (A Division of Basic Products Corp.), **4633 West 16th St., Chicago 50, Ill.

Wall-to-wall lighting with PARAGRID-TILE

A new and important tool in the hands of those who set new trends in illuminating engineering.

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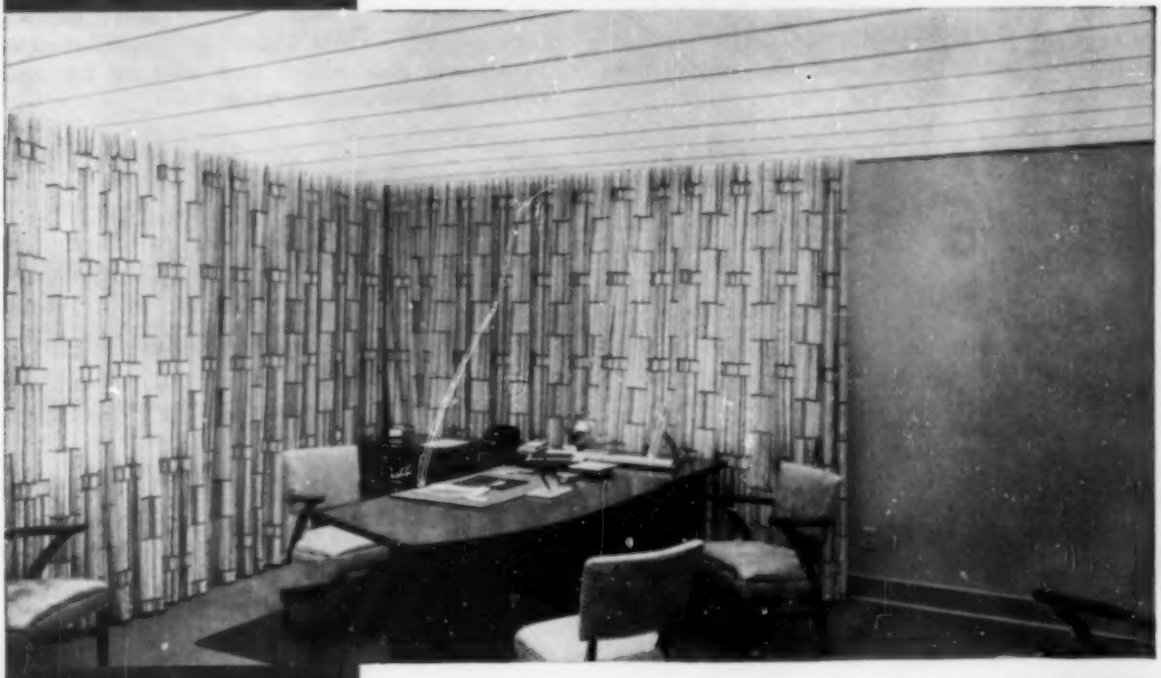
Super-thin U-Trax longitudinal supports (only 5/16" wide) provide minimum interference with efficiency and, combined with directional plastic ribs, give striking appearance.

U-Trax now available in Golden Finish, as well as Standard White.

Try unique Paragrid-Tile, with U-Trax, in one area . . . it will prove its appeal!

Write for descriptive folder



Installation of Paragrid-Tile in office of General Manager, Carling's Breweries Limited, Montreal, Quebec.

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(*Continued from page 10A*)

sented Mr. Zahour, on behalf of the parent Section, a rosewood and sterling silver gavel and sounding block engraved "To New Jersey Section. Charter Night 10/15/58. From New York Section."

Mr. Zahour used this gavel quite promptly to initiate another ceremony which took place at the new Section's Charter Night. This was the presentation by Regional Vice-President Raymond L. Smart, of Certificates of Fellow Grade to three new Fellows, all of the New Jersey Section. New Fellows: Chairman Zahour himself, Svend W. Bruun, and James L. Cox.

Distributed at the Charter Night meeting, and mailed to all New Jersey members, was a wallet-size card listing the new Section's complete program for 1958-1959. This covered the advance program of eight meetings, one each month from October to May. Included in their program will be a presentation of the Progress Report, a School Lighting Clinic, Store Modernization Clinic, High Frequency Application, and the MMILJ contest. Other meetings will feature a Christmas Party, and as a closing event, a Sustaining Member Night Dinner. The new Section also announced a 12-week course in Fundamentals of Illumination under their sponsorship, commencing October 21. Very full-grown, indeed!

CLI Conducts Industrial Lighting Clinic

A full-day clinic on industrial lighting, designed for electrical, plant and maintenance engineers, production managers and others concerned with the design, installation and operation of lighting systems, was held recently at the Chicago Lighting Institute. Registration fee for the six-part program (and luncheon) was $7.50. Co-sponsoring the clinic with the CLI were the Chicago Association of Commerce and Industry, the Chicago Section of IES and the Electrical Maintenance Engineers of Chicago.

Program was as follows:

Morning Session

Chairman — B. D. Allison, Northwestern Railroad and Mayor of Elmhurst, Ill.

Demonstration of CLI Lighting Center — Unique Color and Light — Carl W. Zerseu, Managing Director, Chicago Lighting Institute.

New Lighting Levels (Report on the Blackwell Research) — Richard G. Slauer, Sylvania Electric Products, Inc., Wheeling, W. Va.

Light Sources for Industry — Robert L. Allen, Westinghouse Lamp Division, Chicago, Ill.

Revisions in the Chicago Electrical Code — William P. Hogan, Chief Electrical Inspector, City of Chicago.

Afternoon Session

Chairman — Chester B. Thorsen, Day-Brite Lighting, Inc., Sales Representative and President of Electric Association of Chicago.

Lighting Maintenance, Cleaning Methods and Group Replacement of Lamps — Ken Priestap, General Electric Co., Chicago, Ill.

Engineered Lighting — J. J. McLaughlin, Vice-President, Kelso Burnett Electric Co. and Chairman, Chicago Section, I.E.S.

Following each session there was a discussion period.

SCHEDULED EVENTS

January 19-23, 1959 — American Institute of Electrical Engineers (Winter General Meeting), New York, N. Y.

January 26-29, 1959 — Plant Maintenance and Engineering Show, Public Auditorium, Cleveland, Ohio.

January 27-29, 1959 — Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York, N. Y.

February 8-14, 1959 — National Electrical Week.

February 12, 1959 — Council Meeting, Illuminating Engineering Society, New York, N. Y. Members are free to attend meetings of Council as guests.

March 1-4, 1959 — Second National Lighting Exposition, New York Coliseum, New York, N. Y.

March 1-4, 1959 — National Electric Sign Association, Morrison Hotel, Chicago, Ill.

March 24-26, 1959 — First Biennial Chicago Electrical Industry Show, Hotel Sherman, Chicago, Ill.

March 30 - April 1, 1959 — Chicago Electrical Industry Show, Hotel Sherman, Chicago, Ill.

April 9-10, 1959—East Central Regional Conference, Lord Baltimore Hotel, Baltimore, Md.

April 22, 1959 — Council Meeting, Illuminating Engineering Society, Asheville, N. C. Members are free to attend meetings of Council as guests.

April 22-24, 1959—South Central and Southeastern Regional Conference, Grove Park Inn, Asheville, N. C.

May 3-8, 1959 — Society of Motion Picture and Television Engineers, The Fontainbleau, Miami Beach, Fla.

May 4-5, 1959 — Southwestern Regional Conference, Shamrock-Hilton Hotel, Houston, Tex.

May 6-8, 1959 — Midwestern Regional Conference, Pere Marquette Hotel, Peoria, Ill.

May 11-12, 1959 — Inter-Mountain Regional Conference, Continental Hotel, Denver, Colo.

May 24-29, 1959 — National Association of Electrical Distributors (51st Annual Convention), Conrad Hilton Hotel, Chicago, Ill.

May 26-30, 1959 — Pacific Northwest Regional Conference, Banff Springs Hotel, Banff, Alta.

June 4-5, 1959 — Northeastern Regional Conference, Curtis Hotel, Lenox, Mass.

June 11-12, 1959 — Canadian Regional Conference, Chateau Laurier, Ottawa, Ont.

June 18, 1959 — Council Meeting, Illuminating Engineering Society, New York, N. Y. Members are free to attend meetings of Council as guests.

June 22-23, 1959 — Great Lakes Regional Conference, Statler Hotel, Buffalo, N. Y.

June 22-26, 1959 — American Institute of Electrical Engineers, Summer and Pacific General Meeting, Seattle, Wash.

October 5-10, 1959 — Society of Motion Picture and Television Engineers, Hotel Statler, New York, N. Y.

October 12-14, 1959 — National Electronics Conference, Inc., Hotel Sherman, Chicago, Ill.

October 12-16, 1959 — American Institute of Electrical Engineers, Fall General Meeting, Chicago, Ill.

November 2-5, 1959 — Eleventh Exposition of the Air-Conditioning and Refrigeration Industry, Convention Hall, Atlantic City, N. J.

November 9-13, 1959 — National Electrical Manufacturers Association, Traymore Hotel, Atlantic City, N. J.

Sylvania Plans Merger With General Telephone Corp.

The Boards of Directors of Sylvania Electric Products Inc. and General Telephone Corp. voted approval, in principle of a merger of Sylvania into General Telephone. The legal steps and other details involved are being worked out, and, when completed, will be submitted to the stockholders of both companies. In connection with the proposed merger, the General Telephone Board of Directors also voted to recommend to its stockholders a change in the name of that company to General Telephone & Electronics Corp.

In making the joint announcement, Donald C. Power, President of General Telephone, and Don G. Mitchell, Chairman and President of Sylvania, stated that the plan under consideration would involve the issuance of one share of General Telephone common stock for each share of Sylvania common stock. It is contemplated that Mr. Power will be Chairman of the Board and chief executive officer of the parent company and that Mr. Mitchell will be its President.

Sylvania, which will continue operations as a separate corporate entity, produces electronic components and equip-

(*Continued on page 16A*)

(Continued from page 15A)

ment for industrial, commercial, household and national defense applications; lighting products; television, radio and hi-fi sets; photographic equipment and accessories, and various materials and components. It has 45 plants and 20 laboratories in 13 states.

The General Telephone System is a large independent telephone system, providing telephone service in 30 states and manufacturing telephone instruments and other communication equipment.

IES Appoints Headquarters Office Manager

Appointment of John K. Michel to the newly established position of Office Manager for IES Headquarters has been announced by A. D. Hinckley, Managing Director, to all local and national officers of the Society. Mr. Michel will assume many of the duties previously carried by Mr. Hinckley as Executive Secretary, and this position at Headquarters has been eliminated. It is anticipated that the appointment will provide more efficient and effective operation and membership service.

As part of the new organization set-up developed by management consultants and the IES Council, Mr. Michel will supervise the establishing and maintenance of the Society's membership, financial, legal, official and permanent records; instruct and advise Section and Chapter administrations in preparation and maintenance of all required and recommended Society records and reports,

John K. Michel

as well as supervise general office services located at Headquarters.

Before coming to IES, Mr. Michel spent eight years with Colgate Palmolive Co.'s Research and Development Department where he was engaged in extensive administrative personnel activities and special executive projects. In addition to having completed two years in Science at Manhattan College, he has received his degree in Business Administration from Pace College in New York City.

Lighting Fundamentals Course Offered in Milwaukee

The annual Lighting Fundamentals Course, co-sponsored by the Milwaukee Section of IES and the Wisconsin Electric Power Co. was offered again this year to residents of Milwaukee. Seventy-eight students enrolled for the eight-session program, which was held from October 13 to December 1. Highlight of the group's last meeting was a dinner and social hour.

Included in the program were lectures on: Science of Seeing, Lighting Fundamentals, Light Sources and New Developments, Basic Design Problems, Industrial Lighting, Office Lighting, Lighting for Selling and Outdoor Lighting.

Operations Research Formula Being Developed at Case Institute

A new mathematical formula to tell industry how much money can profitably be spent on research is one phase of a long-term study now underway at Case Institute of Technology, Cleveland, Ohio. The study, which is supported by the National Science Foundation, was described in *Case Work*, a new publication reporting on the research being conducted at the Institute.

During 1959, the Operations Research group, headed by Dr. Russell L. Ackoff, hopes to complete a manual which can be used by individual companies as a guide to the amount of money which should be spent on research and development. A second part of the study will be the establishment of standards for individual research projects so that management will be able to select the best subjects for study.

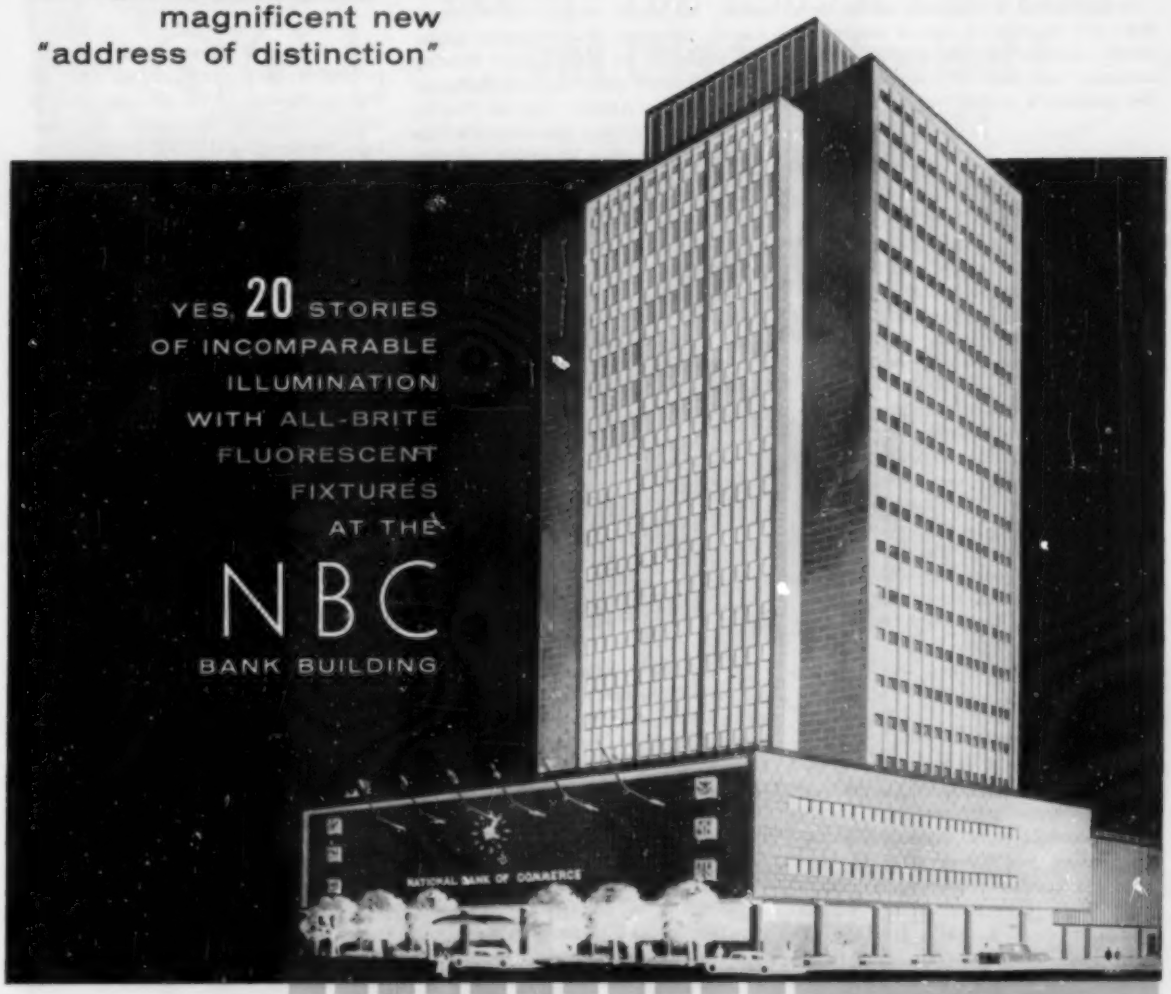
Once the formula is developed for individual firms, it will be extended to an entire industry, and finally to the econ-

(Continued on page 18A)

WINNER of the National Allied Arts Competition, Edward H. Crane (left) accepts his award from A. B. Gallion, Dean of the University of Southern California School of Architecture, at a meeting of the Southern California Section. Seated at right is Section Chairman, Frank B. Lee.

IES'ers in St. Louis, like members throughout the U. S. and Canada are eager for reports on the results of the recent Blackwell researches. Here, Society President George J. Taylor talks at a meeting of the St. Louis Section on the basis for the new footcandle recommendations.

ALL-BRITE
lights San Antonio's
magnificent new
"address of distinction"



Architect: Kenneth Franzheim, Houston. Associate architects: Atlee B. and Robert M. Ayres, San Antonio. Electrical contractor: Paul Wright Electrical Co., San Antonio. Consulting electrical engineer: Dale S. Cooper, Houston.

NEARLY 2000 PEOPLE WORK BETTER, FEEL BETTER, SEE BETTER

All-Brite Constellaire fixtures, installed thruout the new National Bank of Commerce Building, feature LIGHT-STABILIZED injection-molded polystyrene plastic louvers. Result: comfortable 45° shielding combined with beautiful design.

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PLANTS ALSO IN LOS ANGELES, SEATTLE, AND VANCOUVER, B. C.
REPRESENTATIVES THRUOUT THE UNITED STATES AND CANADA

(Continued from page 16A)

omy of the whole nation, showing how the amount spent for research affects the national economic welfare.

Mathematical development of the formula will be directed toward computing which variables in the operation of a company can most effectively increase the company's profits.

Advancement of Science Group To Meet in Washington

The American Association for the Advancement of Science will hold its annual meeting at the Statler Hotel in Washington, D. C. during the week of December 26-31, 1958. The Section M (Engineering) portion of the meeting will be held on December 29th and 30th.

This year's engineering program includes papers on measurement units in the United States and abroad, engineering practices and problems (two sessions) and proposals for the unification and simplification of systems of measurement.

Clarence E. Davies, American Society of Mechanical Engineers is Chairman of the Engineering Section of the AAAS; E. Paul Lange, Engineers Joint Council, serves as its secretary.

R. J. Swackhamer Retires After 36 Years with G-E

R. J. Swackhamer, manager of User Industries Sales at General Electric Co.'s Hendersonville, N. C. Outdoor Lighting Department, has retired after 36 years with the company. He joined G-E in 1922 on the Test Engineering program and later became a floodlighting application engineer in the former Illuminating Engineering Laboratory. A pioneer in lighting athletic fields, Mr. Swackhamer laid out the lighting system for Cincinnati's Crosley Field, the first major league park to install floodlights for night play. Subsequently he contributed to the design of lighting systems for Yankee Stadium, Fenway Park and Briggs Stadium.

In 1950, he became manager of street lighting sales and in 1952 was appointed sales manager for the former Lighting and Rectifier Department. In 1954 he was named to his latest post.

Mr. Swackhamer was chairman of the IES Sports Lighting Committee when it drew up the Recommended Practice for Sports Lighting, and was a member of the committee from 1946 to 1954. He is a member of the Institute of Traffic Engineers, International Municipal Signal Association and the National Sales Executive Club.

Ralph J. Cordiner Honored — Receives McGraw Award

Ralph J. Cordiner, Chairman of the Board of the General Electric Co. received the 1958 James H. McGraw Award, Electrical Manufacturers Medal and Purse, at the 32nd Annual Meeting of the National Electrical Manufacturers Association in Atlantic City on November 12. Mr. Cordiner was cited for "his outstanding personal leadership and continued encouragement and support of the 'Live Better Electrically' program."

The Manufacturers Medal is one of four awards for electrical men established in 1925 by the late James H. McGraw, founder of the McGraw-Hill Publishing Co., each consisting of a bronze medal and purse of one hundred dollars. The other awards are: Contractors Medal, Distributors Medal and the Medal for Cooperation.

ABOUT PEOPLE

Dr. **Robert D. Huntoon** has been appointed to the newly-created post of Deputy Director of the National Bureau of Standards. In this position, Dr. Huntoon will serve as alternate to the Director of the Bureau in external matters and will exercise direction and review over Bureau programs. In addition to his new duties, Dr. Huntoon will continue to serve as Associate Director for Physics.

Day-Brite Lighting Inc., St. Louis, Mo. has announced the appointment, effective October 27, of **William H. Turner** as

(Continued on page 20A)

From the desk of the President . . .

In this second informal across-the-desk talk with IES members, I would like to stress the friendly circle that IES membership completes. You are the beginning of anything that is done; and you are the end, the principal recipient of the benefits which help you do a better job in serving the public.

Every aspect of the Society's work, every elected officer and every committee appointment is initiated by you, the membership. And to complete the circle, it all comes back to you in the benefits accruing from the Society's work. In ways that you may not realize, it is *you* who run the Society.

How? Take membership for instance —requirements in each grade of membership are in the Constitution. Who can approve a change in those requirements? Council? No —only you, the membership.

There is of course, a very important mechanism which is used in IES as in all organizations; that is, you authorize your President and the governing Council to appoint committees to help "run the Society." In the case of membership, you place your trust in those members (the General Board of Examiners) to evaluate the qualifications of applicants seeking to join the Society in the grades of membership you control.

In the same way, a very large proportion of the Society's program is carried out by committees you authorize the President and Council to appoint.

Now, committees don't just happen — a great deal of study each year goes into the review of present committee members and chairmen. There is a continuous effort to find "new blood" and at the same time continue the corps of qualified and devoted committee members who have committee projects in "the works."

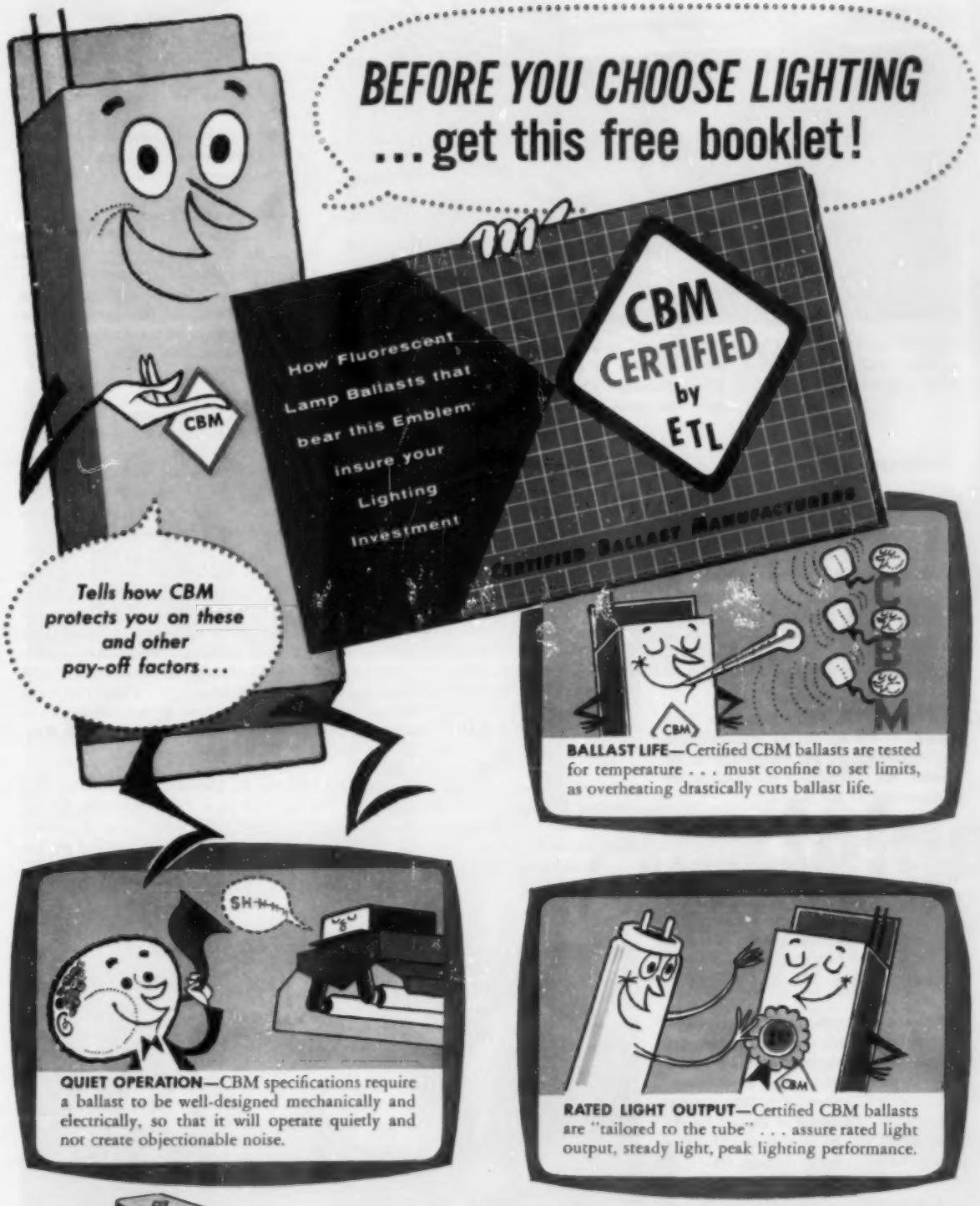
Earlier this Fall, I asked Headquarters to circulate a questionnaire to some 200 members whose names had been submitted for national committee appointment. We asked that any interested member review carefully the list of committees published in the October issue of IE, which gives scope and personnel appointed to that date.

We also reminded prospective committee members that committee service involves work — time, effort and in many instances, expenses of travel to meetings. But committee service is fundamental to the democratic structure of our Society. Are you willing and able to do your part? If so, drop me a note at Headquarters and we will send you the form on which you can detail your part in advancing the theory and practice of illuminating engineering.

In this way you will become, in a very real sense, a part of the "friendly circle" which I know from experience will return to you many-fold in practical benefits and deep satisfactions.

GEORGE J. TAYLOR
IES President, 1958-1959

BEFORE YOU CHOOSE LIGHTING ...get this free booklet!


How Fluorescent Lamp Ballasts that bear this Emblem insure your Lighting Investment
CBM CERTIFIED by ETL
CERTIFIED BALLAST MANUFACTURERS
CBM
Tells how CBM protects you on these and other pay-off factors...
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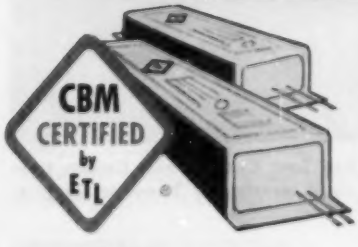
BALLAST LIFE—Certified CBM ballasts are tested for temperature . . . must confine to set limits, as overheating drastically cuts ballast life.

QUIET OPERATION—CBM specifications require a ballast to be well-designed mechanically and electrically, so that it will operate quietly and not create objectionable noise.

RATED LIGHT OUTPUT—Certified CBM ballasts are "tailored to the tube" . . . assure rated light output, steady light, peak lighting performance.



Send for this free booklet and learn how these factors and 11 others help insure your lighting investment when you buy fixtures equipped with Certified CBM ballasts.

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GUESTS of Day-Brite Lighting Inc. on a tour through the company's newly-enlarged Tupelo, Miss. plant, were members of the Mid-South Chapter of IES. After the tour, conducted by Plant Manager Chauncey Godwin and his staff, a buffet supper was served to the guests.

(*Continued from page* 18A)

general manager of Day-Brite Lighting Inc. of Mississippi. Mr. Turner, formerly plant manager for Continental Can Co. in New Orleans, will have his headquarters in Tupelo, Miss. Also announced in connection with the company's newly-enlarged Tupelo plant were the appointments of **Robert D. Glenn, Jr.** as plant industrial engineer and **Charles W. Penley** as industrial engineer.

Raymond W. Cummings has been elected Treasurer of the Crouse-Hinds Co., Syracuse, N. Y., succeeding **J. R. Tuttle.** Mr. Tuttle will continue to act as Chairman of the Board.

Appleton Electric Co., Chicago, Ill., has announced the signing of **Edwin D. Tillson** as consulting engineer to its Lighting Division. Mr. Tillson, who was an independent consultant prior to this appointment, will work directly with **Carl H. Lindell,** chief division engineer at the company's Chicago plant.

Edward Linforth, formerly associated with Rohm & Haas Co, Philadelphia, Pa. is now an independent consultant in the field of plastics and visual environment. Mr. Linforth, author of a 1958 Conference Paper, "Efficiency of Domed Acrylic Skylights," will be located at 107 Green St., Hulmeville, Bucks County, Pa.

J. L. Singleton, vice-president, Industries Group, Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has been elected President of the National Electrical Manufacturers Association for the coming year. The election took place at the Association's 32nd annual convention in Atlantic City, N. J., November 13. Mr. Singleton was elected President of NEMA last July, to fill the unexpired term of the late **W. V. O'Brien** of New York. Elected as NEMA vice-presidents are: A. D. R. Fraser, Rome, N. Y.; Frank H. Roby, Newark, N. J.; N. J. MacDonald, Elizabeth, N. J.; Chris J. Witting, Pittsburgh, Pa. and W. R. Persons, St. Louis, Mo. J. R. MacDonald, New York, N. Y. will serve as treasurer of the Association. Other NEMA elections are as follows: Street Lighting Section — E. B. Karns, Cleveland, Ohio, chairman; Mark Pendleton, Jr., Chicago, Ill., vice-chairman. Floodlighting Section — John A. McDougall, Chicago, Ill., chairman. Industrial and Commercial Lighting Equipment Section — James E. Whitehead, Jr., St. Louis, Mo., chairman; and Clarence C. Keller, New York, N. Y., vice-chairman.

Appointment of **Frank Bernd** as general sales manager has been announced by Curtis Lighting Inc., Chicago, Ill. He succeeds **C. E. Wolfe** who resigned to take a position with the Cardox Corp. For the past two years, Mr. Bernd has been Curtis' Chicago sales manager, and prior to that was sales engineer in the Chicago and northern Indiana territory.

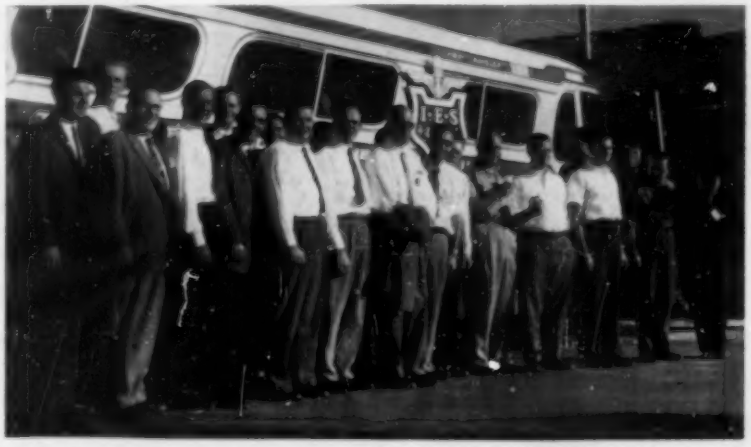
Dr. **Norwood L. Simmons,** West Coast Division, Motion Picture Film Department, Eastman Kodak Co., has been elected President of the Society of Motion Picture and Television Engineers for a two-year term. Dr. Simmons succeeds **Barton Kreuzer,** of the Radio Corporation of America, who will serve as Past-President of the Society.

Litecraft Manufacturing Corp., New York, N. Y. has named **Jack Kilpatrick** as director of sales-engineering development. In this newly-created post, Mr. Kilpatrick will be responsible for effecting and coordinating the company's sales and engineering program.

Pfaff & Kendall, Newark, N. J. has named **Forrest E. Pope,** Burlingame, Calif., to the position of western sales manager. He will cover a seven-state area that includes Oregon, Washington, Idaho, California, Arizona, Nevada and part of Montana. For the past few years, Mr. Pope has been an independent sales representative handling the Pfaff & Kendall line.

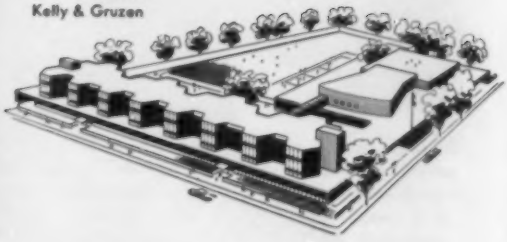
Harry E. Cohane, vice-president and director of sales and advertising for the Verd-A-Ray and Penetry Corp. of Toledo, Ohio has been elected President of the

(*Continued on page* 23A)



BUSLOAD of 78 well-wishers from the San Jose Chapter and Golden Gate Section arrive in Fresno for the charter night meeting of Yosemite Chapter.

Clinton Place
Junior High School,
Newark, N.J.
Architects.
Kelly & Gruzen



READING, WRITING AND Plexiglas LIGHTING

There are good reasons why school builders specify lighting equipment with diffusers of PLEXIGLAS® acrylic plastic. Tough, rigid PLEXIGLAS has:

- Freedom from discoloration
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These advantages add up to *quality* lighting—and today's new schools should have nothing less.

A good example is the prize-winning Clinton Place Junior High School in Newark, N. J., where PLEXIGLAS luminaires are used to light the corridors, library, cafeteria, outdoor walkways, and unique hexagonal classrooms.

Want the names of manufacturers of lighting equipment incorporating PLEXIGLAS? We will be pleased to send them to you.

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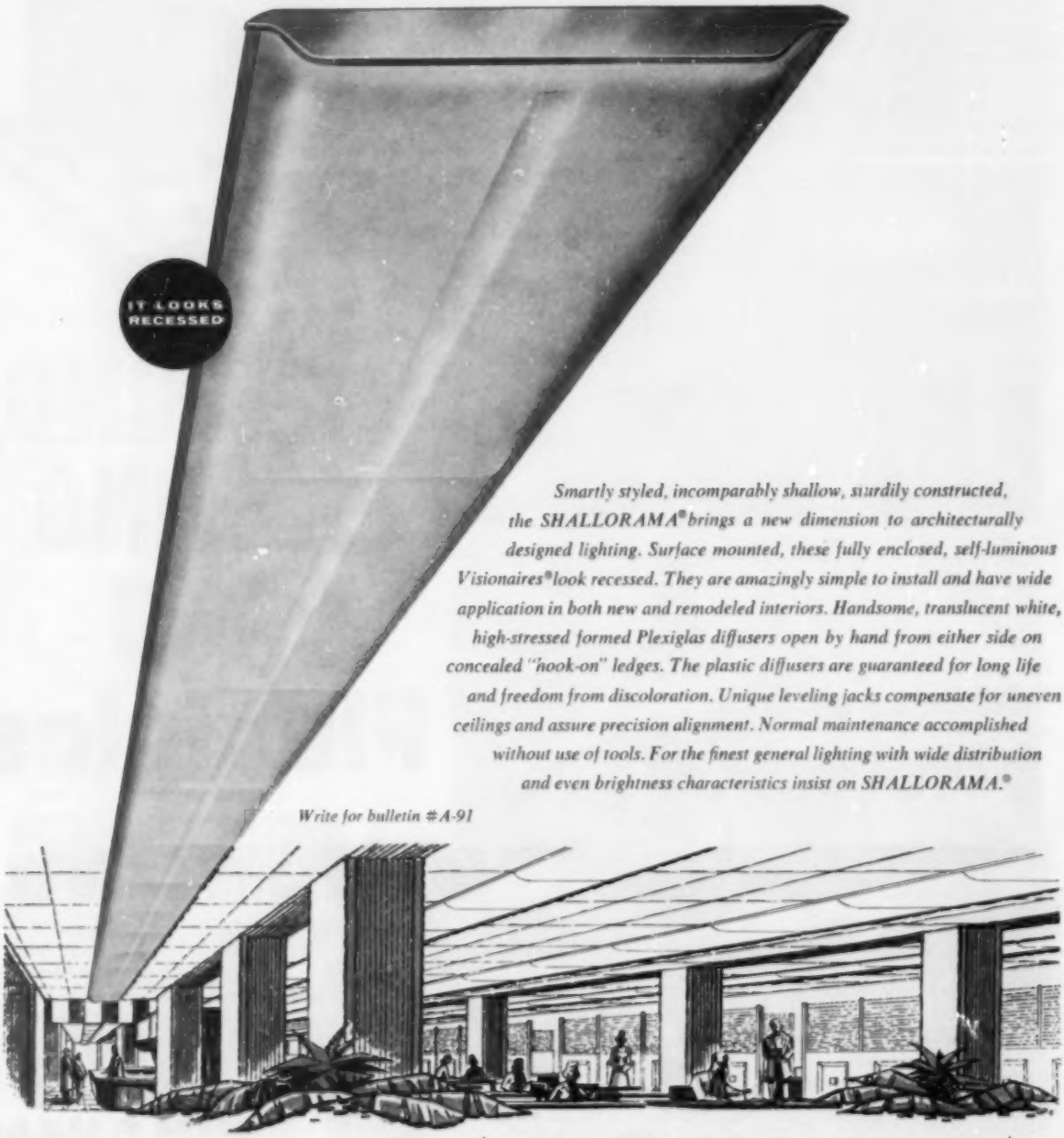
insist on wafer-thin

SHALLORAMA®

for modern, custom-styled lighting



Smartly styled, incomparably shallow, sturdily constructed, the SHALLORAMA® brings a new dimension to architecturally designed lighting. Surface mounted, these fully enclosed, self-luminous Visionaires® look recessed. They are amazingly simple to install and have wide application in both new and remodeled interiors. Handsome, translucent white, high-stressed formed Plexiglas diffusers open by hand from either side on concealed "hook-on" ledges. The plastic diffusers are guaranteed for long life and freedom from discoloration. Unique leveling jacks compensate for uneven ceilings and assure precision alignment. Normal maintenance accomplished without use of tools. For the finest general lighting with wide distribution and even brightness characteristics insist on SHALLORAMA.®

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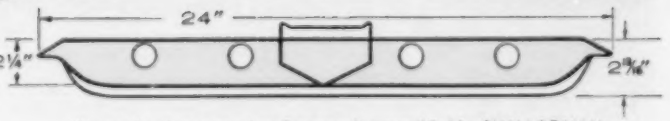
Patents Pending



New peaks of engineered performance is exemplified by SHALLORAMA's soft, uniform diffusion of light and efficient ballast heat dissipation.

Sunbeam Lighting Company, 777 East 14th Pl., Los Angeles 21, California & Gary, Indiana

(Continued from page 20A)

newly-formed Association of Independent Lamp Companies of America. Announced objectives of the Association are to provide better products and services to industrial, commercial and institutional organizations, as well as to create more jobs in the lighting industry.

Francis G. Reed of Toronto, Ont. has announced his entrance into the general practice of architecture. Mr. Reed, formerly associated with the John C. Virden Co., Ltd., in Toronto, has been a registered architect for some 12 years. He will continue to be available as a consultant on illumination design. Mr. Reed's offices are at 48 Cliffside Drive, Toronto.

Fiber Glass Plastic Inc., Miami, Fla. has purchased the assets of the Spun Lite Corp. and moved to a new plant, according to an announcement by **W. Trent German,** president of the firm. The move to the new plant, 7395 N. W. 34th Court, Miami, is the company's third expansion in as many years.

Frank E. Basil Co., Consulting Engineers, Athens, Greece, has announced that **Arthur Belefant** has joined the firm as chief electrical engineer and assistant project manager in the Athens office.

American Standards Association has made known the appointment of four new members to the Materials and Testing Standards Board. These four men had previously been appointed to the Administrative Committee on Standards of the American Society for Testing Materials, and now serve as ASTM representatives on the ASA Board. The new appointees are: **J. L. Menson,** Combustion Engineering, Inc., New York, N. Y.; **F. W. Reinhart,** Chief, Plastics Section, National Bureau of Standards, Washington, D. C.; **S. A. Rosecrans,** Westinghouse Electric Corp., East Pittsburgh, Pa. and **I. V. Williams,** Bell Telephone Laboratories Inc., Murray Hill, N. J.

PAST CHAIRMEN'S Night at the 11th Anniversary Meeting of the Eastern Pennsylvania Section with 8 of the 11 Past Chairmen in attendance. From left to right: M. Ketner, Publicity Chairman; R. A. Reynolds, Secretary-Treasurer; P. H. Hildebrand and W. R. Robeson (obscured); F. E. Heins; J. F. Gallagher, guest speaker; R. J. Pretzman, present Chairman; E. H. Halteman; M. H. Keiffer; P. A. Kinsey; F. M. Gochenaur; E. W. Kelsey.

Arthur G. Plumpton, supervising technician, Illumination Section, Research Laboratory of the Hydro Electric Power Commission of Ontario, has retired after 44 years of service to the Commission. Mr. Plumpton, who was honored with a dinner on the occasion of his retirement, was a member of the Commission's original research group, organized in 1914.

Acquisition of the Benjamin Electric Manufacturing Co., Des Plaines, Ill., by Thomas Industries, Inc., Louisville, Ky., was announced jointly by **Lee B. Thomas,** chairman of the board of Thomas Industries and **John R. Bartizal,** President and chairman of Benjamin, on November 13. The move is subject to stockholder confirmation. The new acquisition will operate as the Benjamin Division of Thomas Industries, with Mr. Bartizal continuing as its head, and no changes in personnel anticipated.

Appointments of the following sales representatives have been announced by Quadrangle Manufacturing Co., Chicago, Ill.: **W. O. Proby** & Associates, Inc., Seattle, Wash., for Alaska, Washington, Oregon and Idaho; **K. E. Ingerson,** Syracuse, N. Y., for the eastern part of upper New York State; **Chassaing** Brothers, Clayton, Mo., for southern Illinois and eastern Missouri; and **Miller** Sales Agency, Rochester, N. Y. for the western part of upper New York State.

George J. Kennedy has been named general sales manager for the eastern region by Day-Brite Lighting Inc., according to an announcement by George J. Taylor, eastern vice-president of the company. Prior to this appointment, Mr.

(Continued on page 24A)

LAMPLIGHTERS (Traffic Safety Committee) of the Southern California Section recently conducted a program on "What Constitutes an Outstanding Street Lighting Job." Attendance at this dinner meeting was 170. Shown here are some of the members of the committee, left to right, Engle Randolph, Charles C. Allen, Committee Chairman Roy Bevan, John G. Weber, Bob Harris, M. B. Gentilon, Gordon Burgess, Jack Naiday, Warren Heer.

I.E.S. National Technical Conferences

1959 — September 7-11 — Hotels Fairmont and Mark Hopkins, San Francisco, California

1960 — September 11-16 — Penn Sheraton Hotel, Pittsburgh, Pennsylvania

1961 — September 24-29 — Chase Park Plaza Hotel, St. Louis, Missouri

1962 — September 9-14 — Statler-Hilton Hotel, Dallas, Texas

(Continued from page 23A)

Kennedy was eastern district sales manager for the Graybar Electric Co. In this new post, Mr. Kennedy will be in charge of sales in the 13-state territory from Washington north and from Pittsburgh east. From the St. Louis office of Day-Brite comes the announcement of the appointment of an additional sales representative, **Charles L. Hitchcock,** in the Chicago area. Mr. Hitchcock will be connected with the firm of C. B. Thorsen & Associates, Inc. of Chicago.

Freedom H. Ainsworth has been elected president of Ainsworth Lighting, Inc., Long Island City, N. Y. Mr. Ainsworth, formerly a vice-president of the company, fills the vacancy left by the death of his father, **George Ainsworth,** who founded the company in 1920. Also announced was the promotion of **George L. Green** from vice-president and administrative officer to executive vice-president and the election of **Robert Greenlee, Jr.,** Mercantile Safe Deposit and Trust Co., Baltimore, Md., as a member of the firm's board of directors.

Announcement has been made of the election of officers of the American Standards Association which took place at the ASA's 40th Annual Meeting on November 20th in New York City. **J. R. Townsend,** Office of the Assistant Secretary of Defense (Research and Engineering), will serve as president of the organization and **Frank H. Roby,** Federal Pacific Electric Corp., Newark, N. J., as vice-president. Elected as directors were **Charles W. Bryan, Jr.,** The Pullman Co., Wilmington, Del., and **T. T. Miller,** Polymer Division, W. R. Grace & Co., New York, N. Y.

G. Franklin Montgomery has been appointed Chief of the Electronic Instrumentation Section at the National Bureau of Standards, U. S. Department of Commerce, succeeding **Carroll Stansbury** who asked to be relieved of his administrative responsibilities because of health limitations. In addition to his duties as Electronic Instrumentation Section Chief, Mr. Montgomery will continue to serve as advisor to the Chief of the Electricity and Electronics Division of the Bureau on all phases of electronic work.

Deaths

Guy Campbell, Charter Member, Illuminating Engineering Society of England.
J. T. Dupree, New Orleans Section.
R. E. Ferguson, Palmetto Section.
T. F. Keister, Miami Valley Section.
D. E. Mozes, Inland Empire Chapter.
Carl Orth, Jr., Northwestern Ohio Section.
F. R. West, Connecticut Section.

BOOKS AND PAMPHLETS

*Books whose reviews are marked * are available for inspection at IES Headquarters, Technical Office.*

***Graphic Science,** by Thomas E. French and Charles J. Vierck, published by the McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 758 pages. $8.50. Illustrated and indexed.

There are three main sections in this book: engineering drawing, descriptive geometry and graphical solutions. The authors are past and present Professors of Engineering Drawing at Ohio State University.

Residential Wiring Handbook, American Standard C91.1 - 1958, published by the American Standards Association, 70 East 45th Street, New York, N. Y. Price: 25 cents.

This Handbook, compiled by the Industry Committee on Interior Wiring Design, has been approved as an American Standard. First issued in 1937, as a section of a book on interior design, the present edition, published in 1954, covers residential wiring only. It is used, with or without local modification, by 129 Adequate Wiring Certification Bureaus in the United States. When used in conjunction with the National Electrical Code (American Standard C1 - 1956), the Residential Wiring Handbook provides a complete guide for safe and adequate wiring in single- and multi-family homes.

Copies are available from Dept. PR28, American Standards Association.

American Standards Z65.3 - 1958, Methods of Determining Areas in Public Buildings, and Z65.2 - 1958, Methods of Determining Areas in School Buildings, published by American Standards Association, 70 East 45th St., New York, N. Y.

These new standards, just published, contain a formula for measuring the floor areas of buildings.

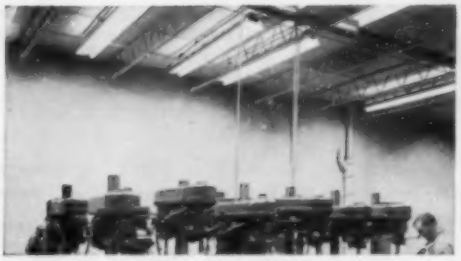
(Lighting News continued on page 26A)

Piscatory Sport Anyone?

John Walsh, general chairman of the 1959 National Technical Conference, demonstrates what even an amateur can accomplish in the waters around the San Francisco light ship. A deep-sea fishing expedition has been arranged for Sunday, September 5, before the San Francisco Conference gets down to the serious business of technical sessions. Frank Duhme, Jr., chairman of the sports committee, also has other activities planned, including golf and tennis.

Whatever your customers want from higher output fluorescents...others are already getting...with G-E POWER GROOVES

THESE SATISFIED POWER GROOVE USERS EACH WANTED SOMETHING DIFFERENT . . . AND ARE GETTING IT!



SHAFER VALVE CO., MANSFIELD, OHIO

WHY POWER GROOVES? Because of improved color rendition and lower lamp replacement cost than mercury lamps.

JOHNSON-HILL'S DEPT. STORE, WISCONSIN RAPIDS, WIS.

WHY POWER GROOVES? To get more light (7½ times as much) from the same number of 40-watt lamps.

ERICKSON TOOL CO., CLEVELAND, OHIO

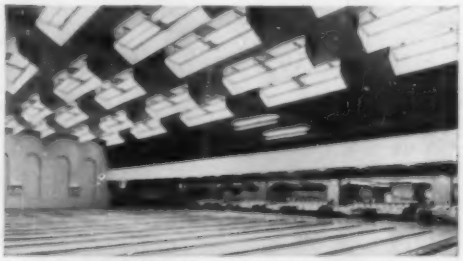
WHY POWER GROOVES? To get higher, more economical production lighting levels (160 footcandles), with no need for supplemental lighting.

GENERAL IRON & METAL CORP., CHICAGO, ILL.

WHY POWER GROOVES? To increase worker efficiency, speed-up production, reduce customer complaints.

CONVAIR, SAN DIEGO, CALIF.

WHY POWER GROOVES? To get the lowest operating cost compared to filament and mercury, and the highest level of light per watt.



PLA-MOR BOWLING ALLEYS, KANSAS CITY, MO.

WHY POWER GROOVES? To provide Pla-Mor lanes with a revolutionary, glare-free lighting system—superior to that in any other bowling center.

Don't *experiment* with your customers' lighting. Give them the newest fluorescent lighting that is endorsed by enthusiastic users all over the country. That *one*, of course, is the *tried-and-proved* General Electric Power Groove Lamp. Think of it! Almost twice the light of High Outputs—more than 2½ times the light output of slimlines! Power Groove users save up to 20% on initial cost, and keep maintenance at rock bottom at the same time. Call your local General Electric Large Lamp salesman right now and let him explain the whole Power Groove story to you. Or write: General Electric Co., Large Lamp Dept. C-839, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC

THREE-WAY COLLABORATION—These men were chief participants in what is thought to be the first joint meeting of three major Societies. New York Sections of IES, AIEE and AIA jointly sponsored the successful dinner meeting October 23 at Hotel George Washington, New York City. Subject: architectural engineering and lighting designs of the Brussel's World Fair buildings. Front row: the three speakers: l. to r. Harry Turko of Edward D. Stone, architects; Rollo G. Williams and Stanley McCandless, both of Century Lighting Inc. Back row, chairmen of the three groups: l. to r. Charles De Carlo, AIEE; John Hamilton, IES; Eustice Dearborn, AIA.

(*Lighting News continued from page* 24A)

NEW MEMBERS

At the recommendation of the IES Board of Examiners, November 13, the following were elected to membership. Names marked * are transfers from Associate Member Grade. Names marked ** are transfers from Student Member Grade.

ALABAMA SECTION

Member:
Thomas, C. L., Jr., Palmer & Baker Engineers, Inc., Mobile, Ala.
Associate Members:
Bennett, G. G., Moore Handley Hardware Co., Inc., Birmingham, Ala.
Thompson, W. E., Dyer Electric Co., Birmingham, Ala.

BRITISH COLUMBIA SECTION

Associate Member:
Mackie, S. W., Lighting Materials, Ltd., Vancouver, B. C.

CAPITAL SECTION

Member:
Hardesty, G. K. C., U. S. Naval Engineering Experiment Station, Annapolis, Md.
Associate Member:
Klein, M. L., A. C. Electric Co., Inc., Washington, D. C.

CENTRAL OKLAHOMA CHAPTER

Members:
*Boyles, L. R., Oklahoma Gas & Electric Co., Oklahoma City, Okla.
*Gow, R. B., Oklahoma Gas & Electric Co., Oklahoma City, Okla.
*Hampton, J. D., Oklahoma Gas & Electric Co., Oklahoma City, Okla.
*Jackson, R. L., Oklahoma Gas & Electric Co., Oklahoma City, Okla.
*Landon, G. K., Oklahoma City Board of Education, Oklahoma City, Okla.
*Magoffin, Sam, Oklahoma Gas & Electric Co., Shawnee, Okla.
*Peavler, B. E., Hudgins Thompson Ball & Associates, Oklahoma City, Okla.
Samis, J. M., Consulting Engineer, 1611 N. Broadway, Oklahoma City, Okla.
*Slief, L. O., Oklahoma Gas & Electric Co., Enid, Okla.
*Wilson, F. W., Floyd Wilson Co., Oklahoma City, Okla.

CHINOOK CHAPTER

Associate Members:
Clark, A. J., Eric Ackland & Associates, Ltd., Calgary, Alta.
Codd, S. R., Warrack Electric Ltd., Calgary, Alta.
Wilson, J. T., Bruce Robinson Electric Ltd., Calgary, Alta.

CLEVELAND SECTION

Member:
*Hanrat..., Lucille, General Electric Co., Cleveland, Ohio.
Associate Members:
Arens, J. B., Westinghouse Electric Corp., Cleveland, Ohio.
Day, J. R., Jewel Electric Products, Inc., Bedford, Ohio.
Kaercher, R. L., Holophane Co., Inc., Newark, Ohio.
Lehr, W. C., The Electric Sales Co., Canton, Ohio.
Routh, D. I., Westinghouse Electric Corp., Cleveland, Ohio.
Wurtzberg, Bernard, Lightolier, Inc., Cleveland, Ohio.
Zaar, G. H., General Electric Co., Cleveland, Ohio.

CONNECTICUT SECTION

Member:
*Smith, A. B., Connecticut Light & Power Co., New Britain, Conn.
Associate Members:
Gould, R. G., Connecticut Light & Power Co., Hartford, Conn.
LaPlant, A. E., Hartford Electric Light Co., Hartford, Conn.

CORNHUSKER SECTION

Associate Members:
Mason, R. H., Graybar Electric Co., Inc., Omaha, Nebr.
Murphy, P. M., General Electric Co., Omaha, Nebr.
Olson, R. W., Westinghouse Electric Corp., Lincoln, Nebr.
Student Member:
Lee, R. M., Iowa State College, Ames, Iowa.

EASTERN PENNSYLVANIA SECTION

Member:
*Moody, F. W., Jr., Pennsylvania Power & Light Co., Harrisburg, Pa.

(*Continued on page* 28A)

1959 Regional Conferences — I.E.S.

Region	Place	Date
East Central	Lord Baltimore Hotel Baltimore, Md.	April 9-10
South Central and Southeastern	Grove Park Inn Asheville, N. C.	April 23-24
Southwestern	Shamrock-Hilton Hotel Houston, Texas	May 4-5
Midwestern	Pere Marquette Hotel Peoria, Ill.	May 6-8
Inter-Mountain	Continental Hotel Denver, Colo.	May 11-12
Pacific Northwest	Banff Springs Hotel Banff, Alta.	May 26-30
Northeastern	Curtis Hotel Lenox, Mass.	June 4-5
Canadian	Chateau Laurier Ottawa, Ont.	June 11-12
Great Lakes	Statler Hotel Buffalo, N. Y.	June 22-23

NEW

K2 Electro-Gard*

Illuminated Exit Signs by

PERFECLITE

There's 100% more Life

in Every Unit

Electro-Gard Exit Units are equipped for two 25 w. lamps but only a single lamp operates at a time. When one burns out, the other comes on instantly due to an exclusive built-in electronic mechanism which works off the same voltage. The results: 100% longer illumination—100% less maintenance worry. And since both lamps do not burn simultaneously, current consumption is greatly reduced as well.

Electro-Gards are available for all surface type and recessed installations. Surface boxes are of 18 ga. press drawn steel, ½" KO's top and side. Recessed boxes are of 20 ga. press drawn steel, six ½" KO's. Both types can also be supplied in aluminum. The die formed 20 ga. steel frame is pivot hinged for easy servicing.

Surface type and recessed units may be ordered in two face styles: hinged metal stencil face, 6" letters on fired green or red glass backing—or 6" letters on fired ceramic glass panel—in four color combinations.

All units are guaranteed for five years.

For further information, mail the attached coupon today!

* Patent Pending

Units are Underwriters Laboratories, Inc. approved, and comply with National Electrical Code

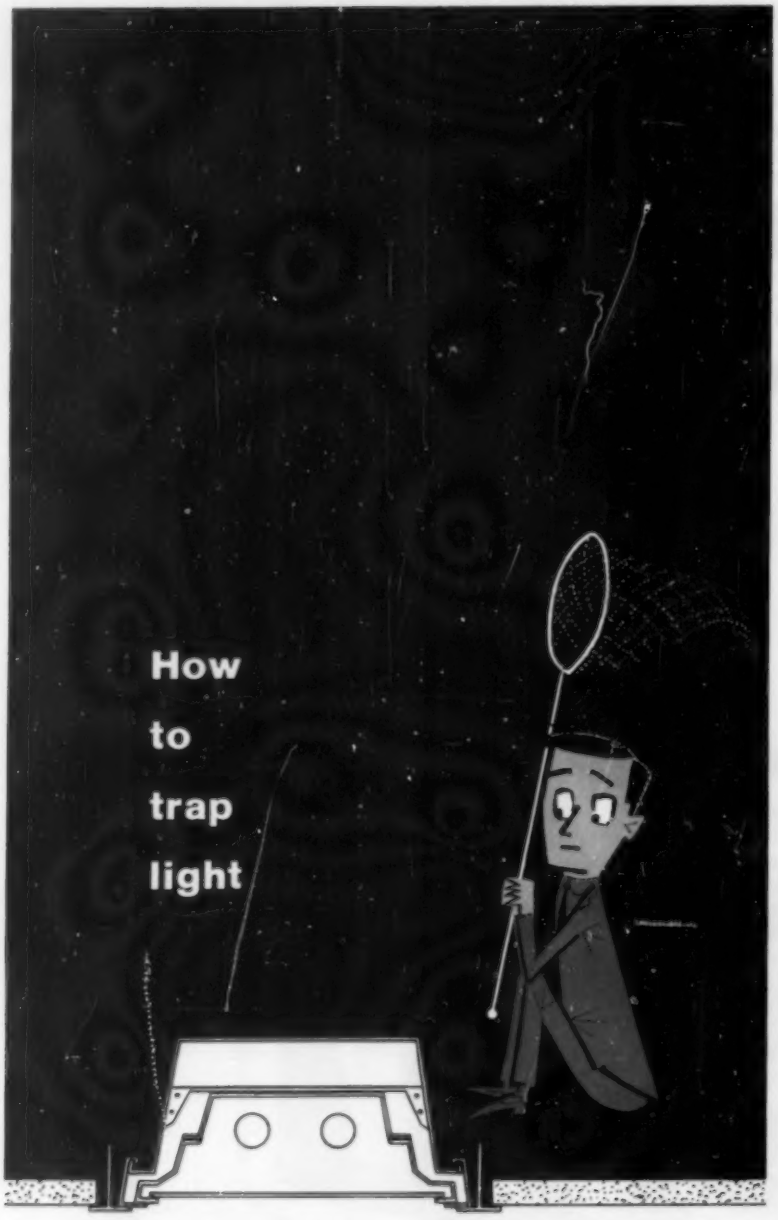
PERFECLITE PRODUCTS
THE MARK OF LIGHTING SERVICE

THE PERFECLITE COMPANY
1457 East 40th Street Cleveland 3, Ohio
Please send me the Perfeclite Data Folder EX-59A.

NAME _____

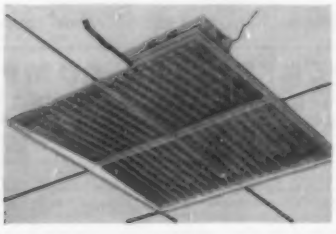
ADDRESS _____

CITY _____ STATE _____



Specify METCO AURORA recessed fluorescent troffers. AURORA's new, exclusive light-tight trim and frame of extruded aluminum seals the troffer body against light leaks, increases useable light output. Write for METCO Bulletin T-1257.

Sold only through qualified electrical distributors.



metco Lighting

METALCRAFT PRODUCTS CO., INC.
Mascher & Lippincott Sts.
Philadelphia 33, Pa.

(Continued from page 26A)

FLORIDA SECTION

Associate Member:
Saussy, Hugh, P. O. Box 2932, Orlando, Fla.

FOREIGN NON-SECTION

Members:
Centanni, Lionello, Westinghouse Electric Corp., Milan, Italy.
Hopkinson, R. G., Building Research Station of D.S.I.R., Garston, Watford, England.

Associate Members:
Gianoli H., Napoleon, Apartado 2240 Miraflores, Lima, Peru.
Cabral, Daniel, The Hawaiian Electric Co., Ltd., Honolulu, T. H.
Canas, A. F., Canas y Sequeira, San Jose, Costa Rica.

HEART OF AMERICA SECTION

Associate Members:
Busby, R. G., American Electric Co., Wichita, Kans.
Collette, W. G., General Electric Supply Co., Wichita, Kans.
Collins, D. G., Kansas City Power & Light Co., Kansas City, Mo.
Custead, J. R., Kansas City Power & Light Co., Kansas City, Mo.
Kimmel, L. T., Thomas Industries, Moe Light Division, Kansas City, Mo.
Mabes, R. H., Kansas City Power & Light Co., Kansas City, Mo.
Metzenthin, W. W., Kansas Electric Supply Co., Inc., Topeka, Kans.
Russell, G. H., Kansas City Power & Light Co., Kansas City, Mo.
Williams, B. G., Kansas City Power & Light Co., Kansas City, Mo.

INLAND EMPIRE CHAPTER

Associate Member:
Vitus, C. J., Columbia Electric & Manufacturing Co., Spokane, Wash.

IOWA SECTION

Associate Members:
O'Dougherty, R. S., Bixler-O'Dougherty, Des Moines, Iowa.
Russell, J. V., Russell Electric Inc., Bettendorf, Iowa.

MARITIME CHAPTER

Associate Members:
Little, W. I., Star Electric Services, Ltd., Moncton, N. B.
Martin, George, Star Electric Services, Ltd., Moncton, N. B.
Melanson, H. J., Acadia Electric, Ltd., Moncton, N. B.
Mooney, J. P., D. Roland Webb & Associates, St. John, N. B.

MARYLAND SECTION

Associate Member:
Robinson, E. K., Holophane Co., Inc., Towson, Md.

MEXICO CHAPTER

Associate Members:
Vizcarra, A. J., Iluminacion Nacional, S. A., Mexico, D. F.
Silveyra, S., Lux, S. A. Monterrey, Mexico.

MID-SOUTH CHAPTER

Student Members:
Arnett, E. G., Southern College of Optometry, Memphis, Tenn.
Fram, Arnold, Southern College of Optometry, Memphis, Tenn.
Pressman, A. E., Southern College of Optometry, Memphis, Tenn.
Stroud, R. G., Southern College of Optometry, Memphis, Tenn.
Wooten, G. F., Southern College of Optometry, Memphis, Tenn.

MILWAUKEE SECTION

Associate Members:
Bloxham, Neil, Good Electric, Milwaukee, Wisc.
Dewhurst, F. A., Duro-Test Corp., Milwaukee, Wisc.
Gumpert, E. M., Bentley-Jones Electric Corp., Milwaukee, Wisc.

(Continued on page 31A)

New CROUSE-HINDS EXPLOSION-PROOF MERCURY VAPOR LIGHTING FIXTURES

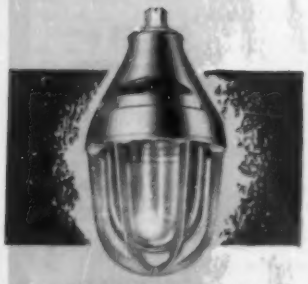
For dependable security at low operating cost in hazardous locations . . .

- *where long burning hours without interruption are involved, month in, month out*
- *where labor cost or trouble of relamping is an important factor*
- *where maximum lighting output calls for maximum economy in power consumption*

The longer life of mercury vapor lamps is well established: 7000 hours, *vs.* 1000 hours for incandescents. Light output is 2.5 times greater; 55 lumens/watt, *vs.* 22 lumens/watt for incandescents.

The new EV's place these economies within easy reach. As with all Crouse-Hinds explosion-proof devices, EV's are heavily constructed to withstand the pressure of internal explosions without rupturing. Gas-tightness is *not* a requirement for their safe performance. Flame-tight joints prevent the escape of flames to flammable atmospheres.

- *For full information, call your Crouse-Hinds distributor, or write for catalog sheet.*



TYPE EVA Explosion-Proof Lighting Fixture

Available with or without guard, or reflector (dome, deep bowl, shallow bowl, angle, or high bay)

250 Watt— National Electrical Code: Class I, Groups C & D

400 Watt— Class I, Group D

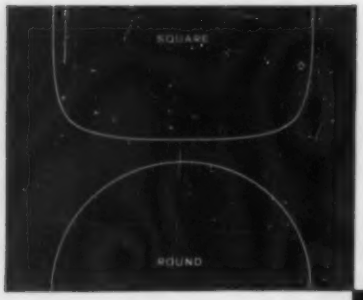
CROUSE-HINDS

MAIN OFFICE AND FACTORY: SYRACUSE, NEW YORK

Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

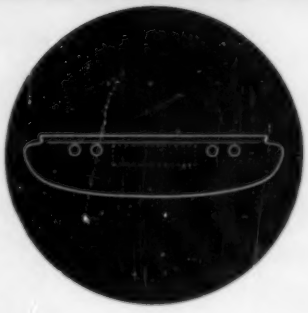
• CONDULET® ELECTRICAL EQUIPMENT (Explosion-Proof and Conventional) • FLOODLIGHTING
• TRAFFIC CONTROL SYSTEMS • AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT

These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Baton Rouge Birmingham Boston Buffalo Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. Salt Lake City St. Louis St. Paul San Francisco Seattle Tulsa Washington **Resident Representatives:** Albany Atlanta Baltimore Charlotte Chattanooga Jacksonville Reading, Pa. Richmond, Va. Shreveport



sculpture in light

CIRCULITE is a rare development in architectural lighting...a completely new full-diffusing light form with a sculptured look. Surface-mounted 24" softened square and round units look almost built-in. They feature a specially regressed housing so the eye sees only a smooth luminous surface at most viewing angles. Light stabilized styrene diffusers are completely frameless, swing down on hidden hinges for easy maintenance. Takes two Rapid Start Circline lamps. A refreshing and exciting treatment for restaurants, lobbies, stairhalls, reception areas, corridors and retail shops. For a 120-PAGE CATALOG-BINDER fully detailing Lightolier's wide range of architectural lighting, write Dept. IE-128.



LIGHTOLIER

ARCHITECTURAL LIGHTING • RESIDENTIAL FIXTURES • PORTABLE LAMPS

MAIN OFFICE AND FACTORY: JERSEY CITY 5, NEW JERSEY

See all the newest Lightolier designs at these authorized distributors:

ALABAMA
Birmingham: Mayer Elec. Sup. Co.

ARIZONA
Phoenix: Brown Wholesale Elec.

CALIFORNIA
San Francisco: California Elec. Sup. Co.

COLORADO
Denver: Central Elec. Sup.

CONNECTICUT
Bridgeport: S. M. Tower
Hartford: Beacon Light & Sup. Co.
New Haven: Grand Light & Sup. Co.
New London: United Elec. Sup. Co.
Stamford: Marie Co.

DISTRICT OF COLUMBIA
Maurice Elec. Sup. Co.
National Elec. Wholesalers
O. K. Evans & Bros.

FLORIDA
Miami: Farrey's Wholesale Hdwe. Co.

GEORGIA
Atlanta: Atlanta Ltg. Fix.
Noland Co.

ILLINOIS
Chicago: Efengee Elec. Sup. Co.
Englewood Elec. Sup. Co.
Hawkins Electric
Hyland Elec. Sup. Co.
Wholesale Elec. Sup.
Elgin: Fox Elec. Sup.
Rockford: Englewood Elec. Sup. Co.
Springfield: Springfield Elec. Sup.

INDIANA
Ft. Wayne: Mossman-Yarnelle Co.
Gary: Englewood Elec. Sup. Co.
So. Bend: Englewood Elec. Sup. Co.

IOWA
Des Moines: Weston Lighting Co.

KANSAS
Kansas City: W. T. Foley Elec. Co.

KENTUCKY
Paducah: Ohio Valley Sup.

LOUISIANA
Baton Rouge: Electrical Wholesalers
New Orleans: Interstate Elec. Co.

MAINE
Bangor: Standard Elec. Co.
Portland: Holmes Elec. Supply Co.

MARYLAND
Baltimore: Oehlle Public Serv. Corp.

MASSACHUSETTS
Boston: Mass. Gas & Elec. Light Co.
Henry L. Wolfers Inc.
Fitchburg: Service Elec. Sup. Co.
Pittsfield: Carr Supply
Springfield: Eastern Elec. Sup.
Worcester: Atlantic Elec. Sup.
Benjamin Elec. Sup.

MICHIGAN
Detroit: Madison Elec. Co.
Michigan Chandelier Co.
Flint: Royalite Co.
Grand Rapids: Purchase Elec. Sup. Co.
Pontiac: Standard Elec. Co.
Saginaw: Standard Elec.

MINNESOTA
Duluth: Northern Elec. Sup. Co.
Minneapolis: Charles A. Anderson & Co.
Northland Elec. Sup. Co.
St. Paul: Lax Elec. Co.

MISSOURI
St. Louis: M. K. Clark

NEBRASKA
Omaha: Electric Fix. & Sup. Co.

NEVADA
Reno: Western Elec. Dists. Co.

NEW HAMPSHIRE
Portsmouth: Mass. Gas & Elec. Light Co.

NEW JERSEY
Atlantic City: Franklin Elec. Sup. Co.
Camden: Camden Elec. Fix. Co.

NEW MEXICO
Albuquerque: Albuquerque Dist. Co.

NEW YORK
Albany: Havens Elec. Co. Inc
Binghamton: Frolio Elec. Sup. Co.
Buffalo: Buffalo Incan. Light Co. Inc.
Niagara Falls: Hyson Sup. Co.
Poughkeepsie: Electra Sup. Co.
Rochester: Rowe Electric Sup. Co.
Syracuse: Superior Elec.

NORTH CAROLINA
Charlotte: Independent Elec. Sup.
Durham: Noland Co.
Greensboro: Elec. Sup. & Equip. Co.
Kinston: Kinston Elec.
Winston-Salem: Noland Co.

OHIO
Akron: The Sacks Elec. Sup. Co.
Canton: The Electric Sales
Cincinnati: B. & B. Elec.
F. D. Lawrence Electric Co.
Cleveland: H. Leff Electric
Columbus: Elgee Elec. Co.
The Loeb Elec. Co.
Dayton: Buellman Elec. Co.
Toledo: Gross Elec.
Youngstown: Marl Industries

OKLAHOMA
Tulsa: Lawson Elec. Co.

PENNSYLVANIA
Allentown: Coleman Elec. Co.
Erie: Kraus Elec. Co.
Harrisburg: Fluorescent Sup. Co.
Hazleton: Power Elec. Co. Inc.
New Castle: Midwestern Elec. Co.
Philadelphia: Ace Lighting Fix. Co.
Gold Seal Elec. Sup. Co.
Sylvan Elec. Fix. Co.
Pittsburgh: Allied Elec. Sup. Co.
Argo-Lite Studios
Doubleday-Hill Elec. Co.
Wally Elec. Sup. Co.
Reading: Coloman Elec. Co.
Scranton: Lewis & Reif
Wilkes-Barre: Anthracite Elec. Sup. Co.

RHODE ISLAND
Pawtuxet: Major Elec. Sup. Co.
Providence: Leavitt Colson Co.

SOUTH CAROLINA
Anderson: Sullivan Hdwe. Co.
Columbia: Capitol Elec. Sup. Co.
Noland Co.
Greenville: Sullivan Hdwe. Co.

SOUTH DAKOTA
Watertown: J. H. Larson Elec. Co.

TENNESSEE
Johnson City: Noland Co
Nashville: Nashville Elec. Sup. Co.

TEXAS
Dallas: Rogers Elec. Sup
Ft. Worth: Anderson Fixture Co.
Houston: Martin Associates
San Antonio: Southern Equip. Co.

VIRGINIA
Arlington: Dominion Elec. Sup. Co. Inc.
Noland Co.
Lynchburg: Mid State Elec. Sup. Inc.
Norfolk: Noland Co.
Roanoke: Noland Co.

WEST VIRGINIA
Charleston: Goldfarb Elec. Sup. Co.
Virginian Electric Inc.
Huntington: West Virginia Elec. Co.
Wheeling: The Front Co.

WISCONSIN
Appleton: Moe Northern Co.
Eau Claire: W. H. Hobbs Sup. Co.
La Crosse: W. A. Roosevelt Co.
Milwaukee: Lappin Elec. Co.
Standard Elec. Sup.

WASHINGTON
Seattle: Seattle Lighting Fix. Co.

ALASKA—Anchorage: Northern Supply Co.

CANADA
Montreal: The Gray Elec. Co.
Toronto: Revere Elec. Dist.
Toronto Elec. Sup. Co.

HAWAII
Honolulu: Hawaiian Light. & Sup. Co.

(Continued from page 28A)

Jost, L. J., Jr., Bentley-Jost Electric Corp., Milwaukee, Wisc.
Montgomery, W. P., Economy Electric Lantern Co., Inc., Sturgeon Bay, Wisc.
Schwind, A. J., A. W. Schwind Co., Milwaukee, Wisc.
Schwind, A. W., A. W. Schwind Co., Milwaukee, Wisc.
Stoiber, W. C., Dietz Electric, Milwaukee, Wisc.
Weisner, M. M., Globe Lighting Inc., Chicago, Ill.

MISSISSIPPI CHAPTER

Associate Member:
Peevey, Paul, City of Jackson, Jackson, Miss.

MONTREAL SECTION

Member:
*Monaghan, B. J., Northern Electric Co. Ltd., Montreal, Que.

MOTHER LODE CHAPTER

Associate Members:
Gill, V. D., Capital Wholesale Electric Co., Sacramento, Calif.
Goldsberry, J. R., General Electric Co., Oakland, Calif.

NEW ENGLAND SECTION

Members:
Newman, L. E., A. L. Smith Iron Co., Chelsea, Mass.
*Thorpe, R. L., Alonzo J. Harriman, Inc., Auburn, Maine.
Associate Members:
Bishop, G. A., Jr., Crawford Electrical Co., Fall River, Mass.
Gale, L. G., 120 Tremont St., Boston, Mass.
Longo, C. J., Jr., Liberty Electric Co., Providence, R. I.
Parker, J. B., Luxor Lighting Products, Inc., Hamilton, Mass.
Pelletier, R. A., Broadway Electric Sales & Service, Fall River, Mass.
Sargent, W. W., Wheeler Reflector Co., Boston, Mass.

NEW JERSEY SECTION

Member:
*Strauss, H. S., Duro-Test Corp., North Bergen, N. J.
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Alles, N. J., National Electrical Contracting Co., Passaic, N. J.
Brundige, W. L., Westinghouse Electric Corp., Bloomfield, N. J.
Horwitz, J. D., Lightolier Co., Jersey City, N. J.
Levine, E. N., Lighting Electrical Service Co., Newark, N. J.
Lingenfelder, E. A., Public Service Electric & Gas Co., Newark, N. J.
Pellegrini, A. L., A. Pellegrini & Associates, East Orange, N. J.
Rissland, M. J., Jr., Public Service Electric & Gas Co., Newark, N. J.
Smith, P. D., Public Service Electric & Gas Co., West New York, N. J.
Thompson, R. E., General Electric Co., Newark, N. J.
Whitley, A. F., Public Service Electric & Gas Co., Newark, N. J.

NEW ORLEANS SECTION

Associate Members:
Hebert, A. C., New Orleans Public Service, Inc., New Orleans, La.
Miller, C. S., New Orleans Public Service, Inc., New Orleans, La.

NEW YORK SECTION

Members:
Gillen, G. J., Consolidated Edison Co. of New York, New York, N. Y.
*Macbeth, Norman, Macbeth Corp., Newburgh, N. Y.
*Murphy, R. J., Consolidated Edison Co. of New York, New York, N. Y.
Associate Members:
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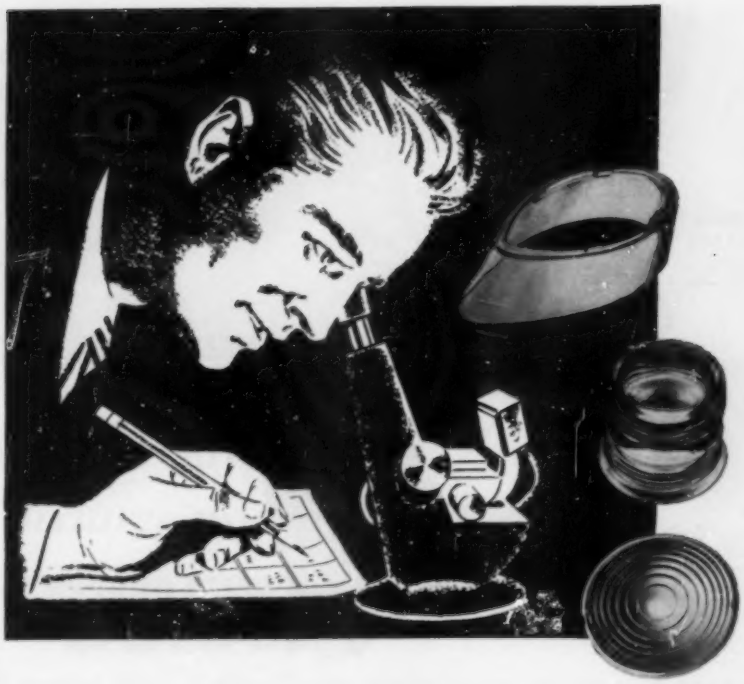
(Continued on page 32A)



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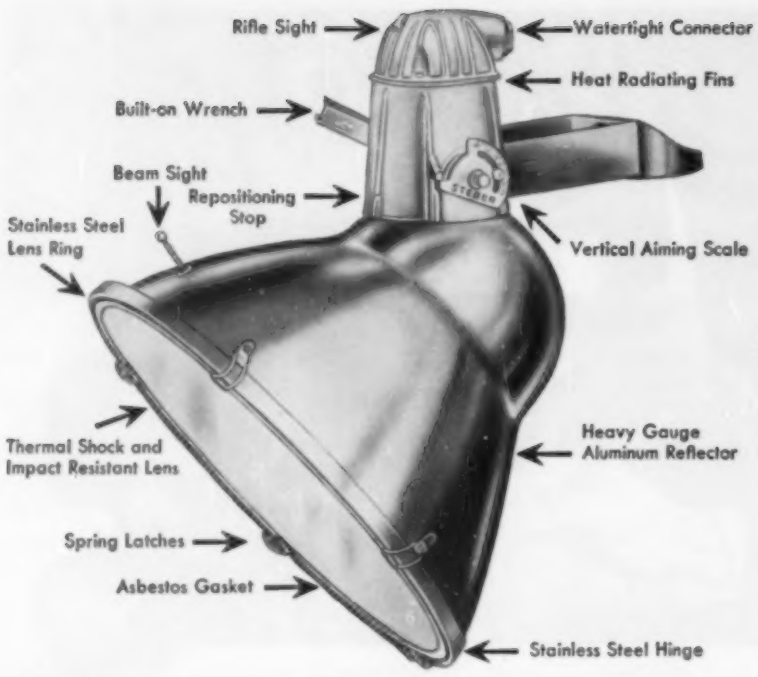

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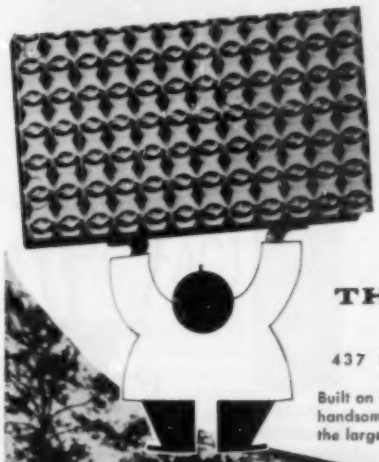

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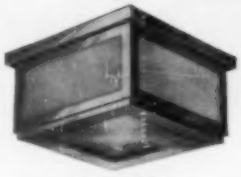

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Surface Square with control lens

NO. 294
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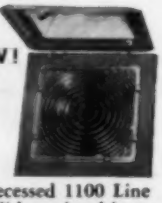
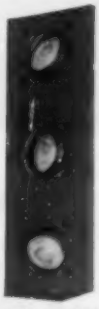


Recessed 1100 Line With spring hinge drop face

NO. 1833
Half Cylinder Pocket, all copper metal.

NO. 1791
Bracket Lantern, all copper metal.



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Direct-The-Lite Adjustable Floodlight Reflectors

NO. 490
Post Lantern All copper metal.

NO. 1150 Recessed Box with Two Gimbal Ring Units (PAR-150W floodlamps and three 100W incandescent.

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a universal outdoor lighting fixture
for post-top or slip-fitter side mount
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IN THIS CATALOG
PAGE
the CIRCLElux 2
electrical characteristics 3
post-top mount specifications and photometric data 4 & 5
slip fitter side mount specifications and photometric data 6 & 7
delivery service 8

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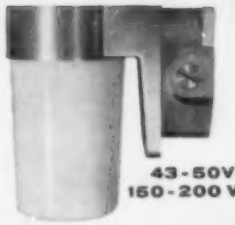

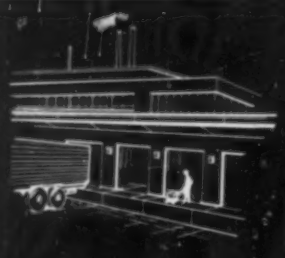

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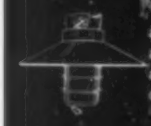

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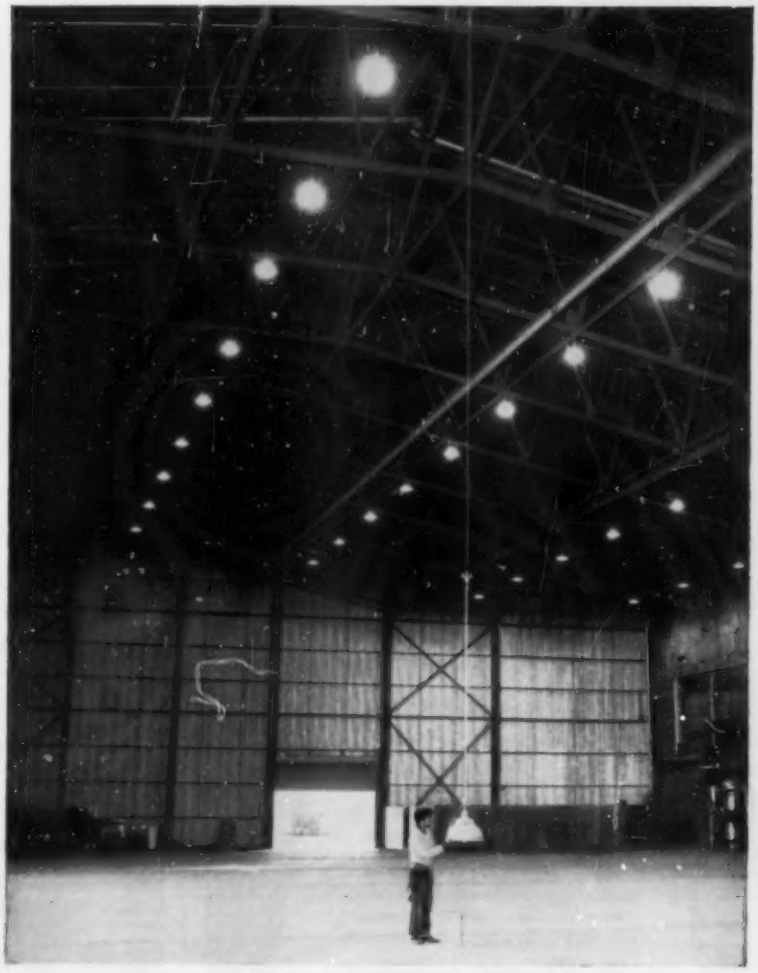

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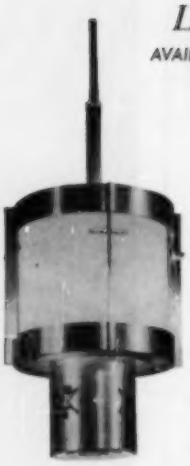

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